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Edited by

Kai Jakobs
Anne Mione
Anne-Françoise Cutting Decelle
Sophie Mignon

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Preface

Back to France. After two conferences in Paris (in 2005 and 2009) it's the South of the country this time – Montpellier. For someone who lives in Aachen (like me) it was quite astonishing how much like a real City a place with slightly over 250,000 inhabitants (like Aachen) can look like …..

'Co-opetition and Open Innovation' may easily be linked to standardisation. Just like pre-competitive research (think the EU's Framework Programmes like Horizon 2020) a standards body's working group is a great place for co-operation between entities that may well fiercely compete elsewhere. Also, work in said WGs may also lead to innovations, e.g. in the form of proactive standards. So, discussing co-opetition and Open Innovation from a standards' perspective definitely makes a lot of sense.

Kai Jakobs
(for the EURAS Board)

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Table of Contents

The Papers

Fatal Competition, Peaceful Coexistence or Active Coopetition Between Traceability Standards in the Distribution Channel?

R. Allamano-Kessler, A. Mione, L. Larroque

MRM, University of Montpellier, France

allamanorenaud@gmail.com

anne.mione@univ-montp1.fr

larroque.fljm@gmail.com

Abstract: *In this work, we observe the situation of rivalry between the traceability standards in the distribution sector. We consider the economic literature about the standardization process between rival technologies in network technologies and the limits brought about by some economists and managers. These limits focus on the systematic character of the model, the undersestimation of the actions of the companies which support these technologies and the automaticity of the choice by the adopters. Our aim is to integrate these elements to propose a model of diffusion. We follow the adopters' point of view and we analyze their position relative to the choice of a standard by using the verbatim accounts gathered from a systematic review of a professional journal. We notice the perception of a standardization movement towards a single standard, rather than the peaceful coexistence of several alternative standards. We note that this standardization movement happened through the competition between two systems (Bar code/ RFID) before evolving toward a more complex mix between these two technologies, which we describe as a situation of coopetition since these systems are rival and mutually exclusive, but they are, however, used in a form combined by customers. We are proposing a model integrating these elements.*

Keywords: *Mutualism-Predation, standards, distribution channels, traceability, coopetition*

1 Introduction

When we consider the situation of the traceability standards in the mass-market retailing channel, we observe the coexistence of several standards, which are rival while being complementary. This situation is surprising since in this context, the advantages associated with the fluidity of information, compatibility and standardization are undeniable. Therefore we examine the strategic and singular choices of the standards adopters by attempting to assess if a standardization phenomenon seems to be emerging and by which dynamics of competition and convergence, it could be activated. Economists and management researchers have been analyzing rivalry situations between alternative technologies for a long time. While economists have given more emphasis to the structuring effects, management researchers have stressed the importance of the actions taken and the implementation of a strategy to establish the dominance of one technology over the other one. (Christensen et al., 1998; Suarez, 2004). When we are in the field of technological standards within the framework of information technologies, the situation is even more tense. The benefits associated with network effects can engage bandwagon process, which make the domination of one technology over the other irrevocable after the first adopters' choice (Arthur, 1989). Small random events have a considerable impact on the technology that will prevail in the end. This competition is fierce and ends with the definitive elimination of the loser. A number of criticisms have been made to this model. They focus on the failure to account for the behavioral heterogeneity of agents, on the necessary contemporaneousness of technologies in the basic model, which theoretically excludes the representation of the established *lock in* situations, and finally on the irremediable character of the technological closure in favour of the technology the positive retroactions focused on (Dalle, 1995; Foray, 1989; Foray and Grübler, 1991). After all, incompatible rival systems may well coexist and management researchers reassess the weight of the players' decisions, which seemed to be neglected by this approach. Beyond the consideration of the image and the reputation of the companies offering a technology, researchers attribute the domination of one technology over the other to the actions led by companies (Suarez, 2004). Through their actions, sponsors support a technology and the strategies carried out will or will not end up in their diffusion on the market. The customer, the one who adopts a standard, can't be limited to follow the movement toward the most popular standard. He keeps his freedom of choice.

In order to try to take into account the decision-makers' freedom of choice, which can comprise hesitations, uncertainties, a wait-and-see attitude, mimicry, we gather the views of adopters in a situation emblematic of the network effects. We choose traceability in the distribution sector because we intuitively perceive the advantages for producers and distributors to share a common system. Consequently, we expect the search for benefits linked to network effects to apply and to bring about a standardization trend. In the mean time, the emergence of new technologies offers a wide variety of writing and reading materials and each company makes its choice by choosing according to its own interests. Is it possible to better understand how this decision is made and can we find a means to integrate these elements in order to model them? By systematically identifying all the articles dealing with the question of traceability in the most widely read journal in the specialized press, we analyze the professionals' written transcriptions to identify the variables which will be used in a new model.

The first part shows the literature review about the standardization process and the emergence of standards and the specificity of the traceability standards in the distribution channel. We show the elements that let us expect a standardization phenomenon, but also the context of technological evolution which produces the diversity of offers. The second part describes the methodology. The third part lists the results and concludes by the proposal of a model. Finally, we discuss and conclude the work.

2 Literature Review

2.1 The Standardization process and Emergence of Standards

The standardization process can first be considered in its global meaning as a strong tendency towards a dominant technology. Suarez (2004) reviews the literature on the battles between technologies leading to the emergence of a dominant technology with regard to its rivals. He underlines how similar the concepts are to describe the same reality. The *"dominant designs"* (Utterback and Abernathy, 1975; Anderson and Tushman, 1990; Utterback and Suarez, 1993), the *"technological trajectories"* (Dosi, 1982; Sahal, 1982) or even the *"platforms"* (Meyer and Lehnerd, 1997; Cusumano and Gawer, 2002), always refer to the situation in which a dominant technology emerges from the rivalry. He chooses the term of technological dominance to account for this observation. Researchers have identified the factors which have an impact in the battle. These are technological superiority, resources, the role of institutions (Suarez and Utterback, 1995; Schilling, 1998; Shapiro and Varian, 1999; Scott, 1994; Scherer, 1992). Some case analyses have described how a technology prevails over the others (*e.g.* Khazam and Mowery, 1994; Garud et al., 2002; Gawer and Cusumano, 2002). Suarez (2004) proposes an integrative model of the process through which a technology manages to dominate the others by underlining the companies' strategic options according to the different steps of the process. With regard to the previous approaches which received the criticism of being *ex post* (Tushman and Anderson, 1986), his approach is *ex ante* and helps to anticipate the dynamics of the dominant design and of the forming of standard.

Economic and management innovation literature on the standardization phenomenon, understood as the domination of one technology over its rivals, is complemented by that of specialists in standards. These are stemming either from the market (*de facto* standards) or from the standards institutions (de jure standards). They are defined as devices, techniques, methods, definitions, which carry out functions of definition, reduction in variety, security and compatibility, and serve the functioning of the market overall. The emergence of these standards offers a competitive potential for the industry (Van de Ven, 1993a; Metcalfe, 1994; Smith, 1997; Tassey, 2000) to produce more, sell more and better communicate with the stakeholders. However, these stakeholders are often different (de Vries, 2006), they can have different interests, different levels of analysis, different financial resources, etc. (Allen and Sriram, 2000; Tassey, 2000; Sherif, 2001; Wang and Kim, 2007; Swann, 2010) and can have conflicting interests (Brunsson and Jacobsson, 2002) : *"Standardizers have no role unless there are people who adopt their standards."* and in the mean time *"Standardizers' more specific reasons for needing adopters, and the kind of adopters that are important to them […]. They need buyers"*. Thus the status of the technical standard pertains to volunteering in order to develop, particularly between the various stakeholders (Brunsson and Jacobsson, 2002; De Vries, 2006), this volunteering may however be mitigated by market situations. A single standard may also be proactive in its implementation and keep a possibility of compliance with legal requirements (Leibrock, 2002). Here we find the whole complexity of the adoption of standards and even more of a de jure standard which gathers different stakeholders while respecting the formalism of standardization (Mione, 2006, 2009, 2014). Consequently, whether it concerns de facto or de jure standards, the harmonization that seems desirable for all players is not simple to implement. In the distribution channel in particular, the adoption of a standard of the traceability process is not simply a debate between different and abstract technologies. This adoption choice consists in a deep questioning of the modes of operation and the relational strategies between all the players in the channel.

2.2 Distribution Channel and Players' Strategies

Since El-Ansary and Stern (1972); Anderson and Weitz (1992); Buckil et al., (1997); Palmantier et al., (2007); Palmantier et al., (2015), we have known that the conflicts in the distribution channel are harmful for the whole channel (Heide and Miner, 1992). Some model (Pondy, 1967; Stern and Heskett, 1969) and measure these conflicts (Hunt and Nevin, 1974; Brown and Day, 1981; Anderson and Narus, 1984). Nevertheless, a collaborative channel, as envisaged by some academic researchers (Bowersox, 1990; Gentry, 1993; Harari, 1999; Christopher, 2001; Zineldin and Bredenlow, 2003; Crujissen et al., 2007; Cao and Zhang, 2010; Zhao et al., 2010) or by some professionals (SCM, Supply Chain Magazine - n°58, 2011; SCM n°60, 2011; SCM n°65, 2012; SCM n°69, 2012; SCM n°70, 2012; SCM n°73, 2013; SCM n°75, 2013; SCM n°79, 2013) is not always easy to implement practically. A problem of information-sharing exists (Gunasekaran and Ngai, 2004). Equally, the integration and the communication of the interfaces of the different systems are important and difficult to operate and it is difficult to make them to cooperate together (Garud and Kumaraswamy, 2005). It is also difficult to put together information and knowledge through the distribution channel. The processes systems and traceability technologies appear to be essential tools to manage the different interfaces of the channel and make the different stakeholders in the distribution channel and sometimes some competitors cooperate (Baski and Kleindorfer, 2009). In order to ensure supplies, timely deliveries, however, it is crucial to create a common language, a norm, a standard to collaborate and ensure the distribution of products to the customers. Competitive stages (between different players, different manufacturers, different LSP, different distributors, etc.) and collaborative stages (information-sharing, knowledge-sharing, etc.) come into play along the distribution channel. In this context, with several stakeholders and several formats, it is interesting to wonder about the emergence of a trend towards the harmonization of standards.

2.3 Traceability: A Trend Towards Standardization?

The concept of traceability is quite recent since it is often associated with that of the distribution channel and supply chains. The beginnings of the Supply Chain Management (SCM) started in the 1960s, when transformations appeared in the way the transport of goods was considered and managed. For Christopher (2005), the supply chain includes a network of firms taking part in the different processes and activities that create value in the form of products or services through forward and backward linkages. The functions of the distribution channel keep on expanding from the distribution logistics to the production logistics, the purchasing logistics, etc. From now on, logistics includes other company functions, such as sales, after-sales service, R&D and reverse logistics (Fabbe-Costes and Colin, 2007). The more complex is the channel – at the level of the flows management, of tracing[1] and goods tracking – the more difficult the management. The objective of the traceability process is then to seek to secure, to track and to trace the goods along the distribution channel. Today traceability is a powerful strategic tool as underlined by Kelepouris et al., 2007; Alfaro and Rabade, 2009; Gottardi and Bolisani, 2009; Ruansook and Thomlchick, 2009). There are different definitions of traceability, which highlight two aspects of traceability, its "ability" to bring together players through relations (Cheng and Simmons, 1994; Moe, 1998; Stabird and Amanor-Bordu, 2007; Skilton and Robinson, 2009; Kumar and Smitz, 2011; Marucheck et al., 2011) *via* physical and virtual interfaces; and its "technical process" of tracing and tracking (Romeyer, 2001; von Drop, 2002; Jansen-Vullers et al., 2003; Golan et al., 2004; Hobbs, 2004; Farris et al., 2005; Karâa and Morana, 2008; Fritz and Schiefer, 2009; Narrod et al., 2009; Heider et al., 2012). Moreover, there are different traceabilities, as upstream traceability, downstream traceability, upward traceability, downward traceability, internal traceability, quantitative logistics traceability (tracking), qualitative logisistics traceability (tracing), semi-open loop traceability (which includes the manufacturer and some players), open traceability (which includes the maximum number of players) and total traceability. These different types of classification of the process of traceability illustrate the difficulty to make the implementation of a universal standard possible. There is rather a traceability process, which unifies several standards and makes them collaborate at different levels and at different times in the production, and this up to the customers. One standard for each traceability, is that feasible? For all the players of traceability? With these numerous definitions, how is the standardization process carried out? Is there a trend towards a single standard?

3 Methodology

Our aim is to assess users' positions. For that purpose, we review the professional literature. We systematically collect the articles dealing with traceability, then we analyze the speech by means of the NVivo software. The gathered elements will enable us to propose a diffusion/dissemination model.

[1] The difference between tracing and tracking is: tracing is the recording of data and information linked to the products and tracking is the monitoring of the products themselves along the channel.

First of all, we scan all of the 101 issues from the journal "Supply Chain Magazine". The major players in the French distribution in all areas contribute mainly to this professional journal. It is aimed at distribution companies, consultants specializing in business strategy and in supply chain management, engineers, PhD students, and is often of interest to the researchers in the fields of business strategy and in SCM, which makes it a widely read journal. In order to assess the trend over the last 10 years, we list the articles which deal with traceability and mention 1D and 2D bar codes, RFID, WMSs, ERPs, etc. and thus assess their mentions over time. We count the words and their associations, spot the issue and the document type (Column, Experience Feedback, File, etc.) in order to uncover the professional coverage of the question of traceability and of the related standards.

3.1 Disclosure Analysis

Concerning discourse analysis, we decide to opt for a manual analysis of the verbatim accounts, and for an analysis via N'Vivo 11 Pro software. A first step consists in carrying out requests linked to the frequency of words with N'Vivo 11 Pro. Then we present the analysis of the verbatim accounts of the professionals interviewed in the articles from the Supply Chain Magazine. A second step in the French professionals' discourse analysis, is their verbatim accounts analysis, which we classify in several categories. These categories will allow us to get the elements that were expected in order to build a quantitative model depending on the verbatim accounts which have been collected.

4 Qualitative Analyiss Results

The results are presented in four parts. First, we give an account of the growing concern over the issue of traceability and over the questioning concerning standards. Then we show what is expected from a traceability system, which allows us to understand both the importance of a harmonized system and the difficulties to achieve this harmonization. The third part describes a historical perspective and highlights how the established standard of the bar code has been destabilized by the arrival of the RFID before evolving towards a richer option. Finally, we describe the elements associated to the competition and the coopetition between systems.

4.1 Total Traceabilty and RFID as Major Concern for Profesisonals

If we only take into account the titles of the issues, we note that RFID technology struggles to stand out as the traceability standard in the distribution channel, as the titles of these articles precisely illustrate.

Table 1. Ranking of key words

Number of articles	Number of times (word quoted)	Word
482	46	Total traceability
454	33	RFID
451	45	Traceability
83	16	GS1
64	17	Standard(s)
46	17	Collaboration
33	10	Mutualization
28	16	Competition
23	14	Norm/Norms
19	8	Standardization
16	83	2D
12	6	ISO

11	7	Cooperation
9	27	1D
5	4	Standardization
3	3	Competition
1	1	AFNOR
0	0	Mutualism

4.2 The Interest of a Total Traceability

The expectations vis-à-vis a traceability system are high. According to some professionals "*The traceability system shouldn't be only conceived to meet standards or react to warnings; it should allow to be proactive. All these collected data are a gold mine which help us understand how flows work and to master them better, optimize them in real time*". Eric Wanscoor, Associate Director of Fluenxi, n°28, 2008, p. 82. As Pierre Corre (co-founder of CPV Associates) specifies, "*The implementation of a specific traceability tool is not the one and only solution. The traceability system must be continuously in real time connection with the existing operational systems and it's difficult to make the whole thing work when an extra layer is added. We must thus include traceability in the existing operational layer, while adapting it to ensure that we have all the necessary functions: field management of logistical units, a database for the gathering, the amalgam and the storage of the information received (WMSs for example), and the capacity to interact with those we want to disclose the information to (intranet site for example)*", n°28, 2008, p. 82. Pierre Corre, co-founder of CPV Associates, adds "*In any case, we have to wonder at all stages – how am I working? What are the management rules, the processes and operating procedures? What the global vision of traceability is, is this.*", Alain Borel, CEO of Valorfi, n°23, 2008, p.82. In addition, we can "*[...] imagine that the traceability tool should be able to calculate a risk index for each product (or each batch), and that it could contribute to proactively adapt the distribution pattern accordingly, [...]*", says Christophe Devins from the company Adents, n°28, 2008.

4.3 Several Dynamics in the Adoption Process

The historical perspective allows us to track several dynamics in the adoption process of bar codes and RFID standards. First, there is an established standardization of the bar code[2] in the distribution channel. This standardization reached its apex in the 1980s, 1990s. The players in the distribution channel share the same traceability technology. It is a *de facto* standardization of the bar code technology, brought about by several technical standards (UPC, Codabar/Monarch, Entrelace, EAN, etc.) which is strengthened by the institutional standardization of traceability (ISO 8402 standard[3] from 1994 and ISO 9000[4] standard from 2000**)**. This standardization is disturbed by the emergence of RFID technology[5]. New options arise for the writing of the code (number of pieces of information contained, organization of information) and for the reading (flash) and we observe a proliferation of reading materials (scans, smartphones, tablets, etc.) and IT applications. The supremacy of RFID, sometimes announced, does not really come true and the different players are looking for possible options between the advantages and the costs of traceability systems. "*Today, we are*

[2] Bar code: representation of a numerical or alphanumeric data in the form of a symbol composed of bars and spaces whose width varies according to the symbology used and of the data thus coded.
[3] ISO 8402 is *"the ability to retrieve the history, the use or the location of an item or an activity, or of similar items or activities, by means of a registered identification"*.
[4] ISO 9000 is *"the ability to retrive the history, the implementation or the location of what is being examined"*.
[5] Radio identification, most commonly known as RFID (Radio Frequency IDentification), is a method to memorize and recover data from a distance by using markers called "radio tags" ("RFID tag" ou "RFID transponder").

witnessing an explosion of technologies for data acquisition. The time is long past when we only use the bar code reader to perform identification", notes Thierry Beclin, Managing director of Psion Teklogix France, n°22, 2008, p. 105. In this phase, characterized by the proliferation of alternative systems, we seek to understand if this is a tricky situation. Do players mention the will to move towards the same system or can incompatible independent systems coexist? What do they think about the adoption of RFID?

4.4 Increases and Dedreases in the Adoption Rate of RFID

The arrival of RFID seemingly generated a craze for this new technology at first. Some foresaw a standardization movement. *"RFID will spread to all spheres of the human life. Our existence will be closely linked to this technology [...]."*, said Gérald Santucci, European Commissioner in charge of questions linked to RFID, n°7, 2006, p. 42. *"The quality and the reliability of the obtained performances suggest that RFID constitutes a real lever of progress for logistics organizations"*, says Xavier Barras from GS1, n°7, 2006, p. 41. A few years later, RFID technology has not stood out as a unique reference in the sector: *"I think that there won't be any RFID wave. Merely a ripple, but which will settle gradually between now and the years to come"*, notes Thierry Vasseur, Managing director of Zebra, n°7, 2006, p. 42. Even later, Jean-Christophe Lecosse warns that *"There won't be any boom for RFID but rather business cases because a unique solution doesn't exist."*, n°81, 2014, p. 91. The utility of RFID is not only associated to a standard status which would allow all users to benefit from the advantages linked with network externalities (Katz et Shapiro, 1985). On the contrary, the advantage gained from the sharing of the same way of storing and reading the data requires a harmonization which is difficult to implement: *"The number of participants in the implementation of a RFID solution adds more complexity to the technology per se. In these situations, the division of roles between software, hardware and consulting is still ill-defined"*, n° 15, 2007, pp. 24-25.

Therefore, to prevail, the technology must prove itself in the organization which implements it, and not for the channel overall fluidity. At this organizational level, several interests are underlined. Some consider that it is the safety brought about which will constitute its competitive edge: *"Today RFID technology addresses inventory problems. But il will truly skyrocket when it will also be used as an anti-theft device"*, predicts Frédéric Dittmar, n°41, 2010, p. 56. It can also be useful to limit forgeries: *"The use of RFID combined with the publication on the EPC network of information concerning a product identified solely throughout the world may contribute to fight against counterfeiting"*, points out Xavier Barras, director EPCglobal France from GS1 France, n°2, 2006, p. 50. Taceability may also help solve follow-up problems that damage the customer relation: *"There are several hundreds of litigations a month, 40% of whom are linked to mistakes on quantity for example. As handling a litigation costs 30 to 50 € to the manufacturer, it adds up to several dozens of thousands of euros a year"*, stresses Lionel Guivarch. *"On 29 January, in a big meeting, we announce the creation of the traceability watchdog as a helping tool for all players"*, explains Pierre Georget, President of GS1 France, n°2, 2006, p. 50. Likewise, the logistics advantages linked to an immediate follow-up are noticed and appreciated: *"From now on, between the moment a Gefco operator flashes a label and the moment the consolidated information is available, 15 minutes pass by. This implies a transparence vis-à-vis the customers and the majors players of the supply chain"*, says Guillaume Rabier enthusiastically, n°96, 2015, p. 51. *"There are many productivity gains at stake in terms of proactivity vis-à-vis the customer through the management of real time alerts"*, he thinks, n°96, 2015, p. 49.

However, the adoption of RFID doesn't necessarily suit all adopters: *"There are Supply Chains which are better adapted to RFID"*, states Jean-Christophe Lecosse, Managing

Director of, n°69, 2012, p. 87. The customers are not always sensitive to the value of information that traceability allows: *"it's rather the absence of customer demand which explains the low equipment rate of some (including the manufacturers)."*, Nicolas Recapet, n°96, 2015, p. 51. Notably, this adoption requires a significant investment that users are not ready to make: *"As long as the additional cost continues, the system won't be able to develop",* explains FM Logistic supported by Pedro Frerrandiz, n°7, 2006, p. 36: *"To scan each box individually caused reliability and productivity problems. As to RFID, it was unthinkable considering its cost"*. Cost does seem to constitute the essential limit to the adoption of this technology: "*It is again the costs (tags, impact on the network, purchase of new reading terminals, etc.) that slow down RFID projects. The technology exists and works but the overall cost remains too high. However, we note that these projects are on the rise and it's clear that the prices should go down in the coming years"*, Catherine Buzaré sums up, n°45, 2010, p. 78. Other difficulties arise as well: *"We have put RFID aside for the moment, Pierre Delval mentions, because it still presents several drawbacks: technologically, it is not compatible with all formats; the frequency standards which are different in the United States, Japan and Europe prevent interoperability; and the encryption keys to secure tags increase the cost of the solution too much."*, n°2, 2006, p. 50. Finally, any change requires a specific handling: *"The fear of a difficult change management remains a real brake on the implementation of traceability solutions of transport operations (in particular for distributors)"*, continues Nicolas Recapet, n°96, 2015, p. 50.

Diffusion didn't really follow a domino effect. To account for this limited success, Patrick Lheure, Retail and Services Mass Consumption Director of CapGemini explains: "*This situation is closely linked to determining factors […] first poor performance of supermarket chains which face stiff competition from hard discount has led managers to focus their efforts on marketing and sales. In this context, RFID is not the priority anymore"*, n°7, 2006, p. 46. "*At the end of 2008, a certain number of logisticians and large retailers were already starting to slow down their investment a little. The trend was felt in anything related to the purchase of equipment at the start, and we experienced this decline over the first six months of 2009"*, remembers Djaffar Ferrat, Manager of Zetes France, n°41, 2010, p. 5. This situation disappoints logistics providers who are particularly sensitive to the integration of the different players in the distribution channel. Consequently, Gérard Pineau, managing director of FM Logistic, regrets that *"no supermarket chain has the will to invest heavily in this promising technology for the moment."*, n°15, 2007, p. 25. *"The reliability of reading equipments and the standardization of systems are all constraints to eliminate. But without waiting for mass retailers, producers and logisticians should get on, because the future will involve RFID anyway."*, he adds. Concerning competition, the technologies are envisaged, either in a competitive struggle, i.e. one facing the other, or in a coopetitive combination, i.e. by coupling the rivals together and by organizing a form of cooperation in this way.

4.5 Competition Between Technologies at Technologies at Work

Initially, RFID technology was considered as the future emerging standard. In network technologies, a standardization movement through competition or convergence often happens when there is a proliferation of rival technologies (Arthur, 1990). It's probably the expectation of such a standardization phenomenon which leads Eric Delanneau, marketing and communications manager of Intermec, to note that *"The small world of automatic identification is about to experience its most fundamental change since the introduction of the bar code"*, n°9, 2006, p. 52. Even more expressively, Xavier Barras, director of EPC Global GS1 France, expresses his confidence: *"In 2010, 100 billion communications machines will be interconnected. RFID will undoubtedly be at the very heart of this evolution with chips no bigger than a few hundred microns"*, n°2, 2006, p. 41.

Opting for RFID seems to mean giving up longer existing traceability means. The logistics service providers talk about “a full solution”: *“This time, some projects have been signed, not as pilots anymore, but as full solutions. We have signed a nice deal with Carrefour on RFID for which Zetes has been asked to build up the solution and implement it in a consolidation centre”*, says Djaffar Ferrat, n°41, 2010, p. 56. The idiom “take the plunge” toward RFID technology confirms that it’s an exclusive technological option: *“This difficult step on the economical level allowed customers to better face reality and the ROI they could spot on the field with RFID. Those who have decided to opt for RFID this year are people who have skipped the step of the techonological pilot in order to reach the step of the functional pilot. For us, 2009 has been a catalyst for some customers who thought that if they didn’t go for it then, they would delay their projects for three years without any immediate benefit.”*. *“Indeed, everything we have signed or implemented is projects where the ROI was really proven, particularly in RFID”,* agrees Emmanuel Royet, Sales director of Intermec France, n°41, 2010, p. 51. *“Among our members,* says Xavier Barras, Innovation and Technology Director of GS1 France, *we could point out tow major trends: on one hand, the capitalization on the investments already made, and on the other hand the choice for projects, which are breakthrough in their processes, on technologies such as self scanning or RFID. These are not necessarily large-scale projects, but we notice that there are still investments that are possible because the potential gains are significant in terms of productivity and return on investment”*, n°41, 2010, p. 56.

The competitive mode is also adopted by sponsors of the bar code standard destabilized by RFID. Similiarly, the term used is “revolution” hinting that alternative projects will be swept away by “the 2D anticipated revolution” thanks to its connection between interfaces and the customer services (the customer’s lead): *“The great revolution that the bar code will experience in the years to come is that it will be readable on any mobile phone with a camera*, announces Christian Martin. *By pointing one’s mobile phone to a 2D code, a small decoding software will indicate that the code has been recognized by the camera. The applications for the consumer are various: personal data, direct access to the Internet…"*, mentions Éric Delanneau from Intermec, n°9, 2006, p. 54. The 2D bar code constitutes a response concerning the threat of RFID. The bar code appears to be an alternative to RFID and proposes to combine a moderate cost with the possibility to include more information. *“The success of 2D code (Damtrix or others) comes from the fact that it contains a maximum of information in a minimum of space”,* thinks Eric Delanneau, p. 57. It is an alternative technological offer which is incompatible with RFID. *“The advantage of 2D, is to be able to include a considerable amount of information in an ever smaller space. The limit is the absence of interactivity that we can get with RFID, particularly with GEN 2”*, adds Eric Delanneau, n°30, 2008, p. 55. However, both systems remain incompatible, which doesn’t allow for the optimization of information management. As Nicolas Recapet, Supply Chain Manager of Cereza points out: *“It must be emphasized that no solution fully covers the 2 major expectations in terms of traceability management of fleet and operations monitoring”,* (n°96, 2015, p. 49). That’s why other strategies emerge, which open a hybrid competitive space beween competition and rivalry.

4.6 Coopetaion Through the Search for Convergence

Along the channel the players’strategies can make these competing technologies cooperate in order to ensure a greater traceability. These strategies of the linking of competing standards offer a market which is promising for the future. On this topic Thierry Vasseur, *Europe Middle Est Africa Sales Director of Zebra Technologies, notices: “People first wanted to replace a technology by another one, but we realized it was not the right solution. Today, we can associate the bar code, speech and RFID within the warehouse, and, indeed, there is a* *tremendous growth in this field at the moment."*, n°22, 2008, p. 106. Christian Martin, CEO of Alphacode agrees with this combination: *"Indeed we talk about RFID as the successor of the bar code but the promising past articles and predictions have recently given way to analyses which are more conservative and more detailed and to tests which show the technological, financial and use-related limits of applications of radio frequency. That's why a growing number of manufacturers think that the convergence of 2D codes between objects, printed material and telecoms is as promising and efficient as RFID and very complementary."*, he says, n°8, 2006,vp. 62.

The convergence is done by including different systems, by the search of compatibility, of interoperability, whose strongest advocates are logistics providers. *"I insist, vis-à-vis our final customers: to make all this work is not done at the snap of the fingers, this is not what happens on a daily basis. All these layers included in the terminals will have to be developed, characterized, tested, made more reliable and synchronized with one another. The fact that each one works very well individually doesn't imply that they will do it well with each other"*, Thierry Beclin, n°2, 2006, p. 112. For Eric Delanneau, Marketing and communications manager of Intermec, it is the versatility of the devices which create new dynamics: *"We can't really talk about innovation. What is new, however, is the gathering, in one single device, of several technologies of identification and transmission. The new models are RFID compatibles, include voice and communication recognition, are open and offer large communication capacities"*, n°9, 2006, p. 52. The combination generalizes: *"The majority of the RFID projects we deal with are mixed, that is to say combine bar codes and RFID"*, states Bernard Pagnon, Commercial Director of Inotec. Some prescribe a dual system of traceability: *"We wanted to be ambitious by investing in a dual system of traceability which would allow us not only to respond in case of crisis, but above all to improve our performances"*, stresses Frédéric Schneider, Supply Chain manager of Stoeffler, n°1, 2005, p. 31. The information system is enriched by the technology coupling: *"We can couple this information to other information (via its bar code or its RFID chip). Then we can track this information in real time, thanks to the GPRS, which allows us to check if the actions have been properly carried out… Two solutions per player are used on average",* says Nicolas Recapet, n°96, 2015, p. 49. *"We can know the precise position of the product, know if it's in the right place, if it has been moved. From there, we can also record the moves, analyze the information, find improvements to optimize procedures and reinforce the company efficiency"*, explains Christian Girard, n°9, 2006, p. 53. *"There are applications which use radio tags in the mass storage where we have found intersesting ROI, for example by equipping warehouses with RFID Mojix read heads, coupled with WiFi, which manage both classical traceability and geolocation of palets within five meters. There are two realizations of this type in the distribution sector in France"*, notes Franck Murard, n°41, 2010, p. 56. Information management opens up new opportunities and the possibility of value creation: *"I think that all these technologies allow builders like us to offer products ranges which are more and more specialized. These ranges of products widen to address more and more particular markets, that's a major change that our industry has been experiencing for three or four years. It's very exciting by the way"*, Thierry Beclin, n°2, 2006, p. 112.

We have identified contradictory movements in the technology diffusion, contradictory players' strategies between the sponsors of the system unification and the adopters who arbitrate between costs and particular advantages and finally complex competitive situations between harsh competition and coopetition (Nalebuff & Brandenburger 1996[6]). In the next

[6] *"Co-opetition is in the air, and want to encourage this shift away from the focus on competition that has dominated much of business strategy. [...] Business is cooperation when it comes creating a pie, and*

part, we will try to take into account these different elements, particularly the singularities of adoption and we will propose a model including this complexity. We propose to build a dynamic model to characterize what we call a mutualism-predation (Competition-Coexistence-Coopetition) in the adoption of standard(s).

5 Modelling a Situation of Coopetition and Copetitive Strategies by Stakeholders

If Arthur (1989) models the competition of the adoption of a standard which takes precedence over the other, his approach is derived from a physical model, which he applies to the diffusion of a standard. This model is innovative, however, it is not, strictly speaking, an economist's model, based on utility calculations, nor a games theoretician's model (even if the dual aspect of the two standards is present just like the probabilistic approach). From a strategic view point which relates the daily difficulties, there is not really any approach quantitatively modeling these field singularities which fluctuate as the professionals' verbatim accounts show. Also, Arthur's approach (1989) does not take into account the competitive dimensions or rather views competition as the making of the choice of adopters and the knock-on effect which irrevocably lead to the domination of one technology over the other. On the contrary, our strategic focus leads us to take into account competitive relations at the time of the rivalry. Yet, we have noticed how hybrid this competitive situation really is.

We have seen that it gave way to combinations in spite of two incompatible systems. Barnett and Carroll (1987) and Barnett (1990) have precisely identified this combination between cooperation and competition in the situation of rivalry between systems in the telephony technology. They study the diffusion of the telephone in the United States at the very beginning of the 20th century. Inspired by the environmentalists in the population to report the interdependence between players (Hannan and Freeman, 1977), they showed that in the situation of a new technology, developing in rivalry with others, the mutualism which serves the overall advantage is combined with competition. More precisely, the systems can share the same standard or not, which provokes competition. When technologies are standardized, organizations combine this mutualism with competition through their differentiation. The authors base their reflection on Atwood's work (1984). They propose different models based on data which illustrate these ambiguities, namely geographical ones. Thus, they conclude that the relations between competition and mutualism are ambiguous in the spread of telephone lines, and that it depends on the geographical areas and that: *"Interestingly, the apparent resilience of telephone companies to environmental factors also supports the community hypothesis."*, p. 418. This harkens back to Van Beneden's idea (1875) according to which we can be more mutualist at certain times and less, or not at all, at other times. The common aspect of mutualism can be linked with commercial competition to develop and grow. Applied to our situation of adoption of standard(s) of traceability in the distribution channel, the cooperative and competitive tensions can be considered as a mutualism-predation process in the sense that overall mutualism prevails to ensure the coherence, the stability and the continuity of the system and that in the mean time, intra-organizational individual competitive initiatives *(e.g. L'Oréal and the Kiss System),* or strategic partnerships *(e.g. Geodis Logistics, Monoprix, Yves Rocher*) are developped. We have also underlined how the customers finally put the suppliers in competition – cooperation by coupling incompatible offers. Therefore, we prefer the term coopetition. We draw upon the initial definition of coopetition by Brandenburger and Nalebuff (1996) who have founded their model in the

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competition when it comes to dividing it up. This duality can easily make business relationships feel paradoxical.", p. 264.

theory of games. Other authors have then attempted to model coopetition, as for example, Soubeyran and Weber, 2002 ; Lopez-Gomez and Molina-Meyer, 2007 ; Okura, 2007 ; Baski and Kleindorfer (2009) ; Zhang and Frazier (2011) ; Carfì and Schilirò (2012). However, these authors are more economists, mathematicians than strategists, and the models discussed are more theoretical than practical. We thus include the complexity of the field players in a formal model of competition by inserting flexibility through a positive term of cooperation and a constant of the imperatives that the field supposes. We model with Lotka (1925) and Volterra (1931) equations as a basis, which propose a model of predation by adding more terms, to include complexity and a field constant to report on the adopters' decision. Thus and in accordance with the professionals' verbatim accounts, acceleration and deceleration phases, of competition and coopetition in the adoption of standard(s) will be present.

This model is not a probabilistic one as Arthur's (1989) which uses a linear model of $\alpha_R + rn_\alpha$ type and adds a probabilistic term of $p(n_a, n_b)$ type for equation 1, and the additional probabilistic term $1 - p(n_a, n_b)$ for equation 2, or that of Cowan (1991) or else the model of diffusion of standard David (1987) which builds on Arthur, Ermoliev and Kaniovski's theorem (1986). To mode this phenomenon of adoption of standard(s), of a standardization and of the complex links which exist in this adoption of traceability standard(s). We prefer to propose a model where more singularities are expressed. That is what allows a model of differential equations derived from population ecology and then developed by managers (Aldrich, 1979; Addicott, 1981; Barnett and Carroll, 1987; Hannan, 1988, 2005; Astley and Fombrun, 1993; Hannan and Freeman, 1997). The model includes the complexity of phases of competition between technology standard(s) and intra-standard(s) and inter-standard(s) more collaborative phases. He emphasizes a mutualism-predation of the adoption of standard(s) of traceability in the distribution channel. It is a mutualist-predation model which does not present a sheer mutualism as a symbiosis or as a mutualism as described by Meyer et al. (1975). The mutualism described here is a mutualism-predation (with a dominant of competition in several phases) which can exist between two standards (here between the bar codes (cb_{1D} et cb_{2D}) and the competing standard $RFID$. This model presents as follows:

$$\begin{cases} \dfrac{\partial cb_{1D/2D}(t)}{\partial t} = r_1 cb_{1D} - \alpha_1 cb_{1D} RFID + \beta_1 cb_{2D} RFID + \gamma_1 cb_{1D+2D} RFID + \delta_1 cb_{1D} cb_{2D} RFID + \varsigma(ci, bi, pi) \\ \dfrac{\partial RFID(t)}{\partial t} = r_2 RFID + \alpha_2 RFID cb_{1D} - \beta_2 RFID cb_{2D} - \gamma_2 RFID cb_{1D+2D} + \delta_2 cb_{1D} cb_{2D} RFID + \varsigma(ci, bi, pi) \end{cases}$$

This system represents two nonlinear differential equations. Each equation is composed of five members which are functional relations associated to the different predation relations, of cooperation between competing standards. Let's present the parameters used as follows:

Table 2. Meaning of parameters

Parameters	Meaning
$\boldsymbol{r_1}$	$\boldsymbol{r_1}$ is the intrinsic growth rate of the technology $\boldsymbol{cb_{1D}}$
$\boldsymbol{r_2}$	$\boldsymbol{r_2}$ is the intrinsic growth rate of the technology $\boldsymbol{RFID}$
$\boldsymbol{\alpha_1}$	$\boldsymbol{\alpha_1}$ is the loss rate of $\boldsymbol{cb_{1D}}$ with respect to $\boldsymbol{RFID}$
$\boldsymbol{\alpha_2}$	$\boldsymbol{\alpha_2}$ is the predation rate of $\boldsymbol{RFID}$ with respect to $\boldsymbol{cb_{2D}}$
$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_1}$ is the predation rate of $\boldsymbol{cb_{2D}}$ with respect to $\boldsymbol{RFID}$
$\boldsymbol{\beta_2}$	$\boldsymbol{\beta_2}$ is the loss rate of $\boldsymbol{RFID}$ with respect to $\boldsymbol{cb_{2D}}$
$\boldsymbol{\gamma_1}$	$\boldsymbol{\gamma_1}$ is the predation rate of the association of $\boldsymbol{cb_{1D+2D}}$ with respect to $\boldsymbol{RFID}$
$\boldsymbol{\gamma_2}$	$\boldsymbol{\gamma_1}$ is the loss rate of $\boldsymbol{RFID}$ with respect to the association of $\boldsymbol{cb_{1D+2D}}$

$\boldsymbol{\delta_1}$	$\boldsymbol{\delta_1}$ is the rate of positive association (cooperation) between $\boldsymbol{cb_{1D}}$, $\boldsymbol{cb_{2D}}$ and $\boldsymbol{RFID}$
$\boldsymbol{\delta_2}$	$\boldsymbol{\delta_2}$ is the rate of positive association (cooperation) between $\boldsymbol{RFID}$, $\boldsymbol{cb_{1D}}$ and $\boldsymbol{cb_{2D}}$
$\boldsymbol{\varsigma}$	$\boldsymbol{\varsigma}$ is the constant which depends and is determined by the costs *ci*, and the need in distribution *bi* and the pressure *pi* from the players Manufacturers, Distributors, PSL or GS1.

The differential equations 1 and 2 describe the characterization of adoption, of conservation of adoption in the predation and the cooperation between the bar code standard and the RFID standard. These equations are divided in five terms and a constant, which we call the *"field constant"*. It exists and differs for all companies depending on their field imperatives.

The first term characterizes the capacities and the possibilities of development of the 1D bar code (namely the intrinsic growth of the 1D bar code technology) or it characterizes the capacities and possibilities of development of RFID technology (namely the intrinsic growth of RFID technology).

The second term characterizes the predation of the RFID tag on the 1D bar code, hence the sign $-$ or just like it characterizes the predation of the RFID tag on the 1D bar code, hence the sign $+$.

The third term characterizes the predation of the 2D bar code on RFID, the 2D bar code costs less than the RFID tag, it is easier to use and by a greater number of players and by a larger variety of players (Manufacturers, Logistics Service Providers, etc.), hence the sign $-$ or $+$ in the second differential equation.

The fourth term characterizes the predation of the association 1D bar code and 2D bar code on the RFID tag, here the predation is even more important than in term n°3, hence the sign + or just like it characterizes the predation of the association 1D bar code and 2D bar code on the RFID tag, here the predation is even more significant than in term n°3, hence the sign $-$.

The fifth term characterizes the positive association of the bar code and of RFID along the distribution channel, hence the sign $+$ or just like it characterizes the positive association of the bar code and RFID along the distribution channel, hence the sign $+$.

The constant characterizes the incompressible imperatives of distribution for a player which wants to opt for a standard or for another one (as the costs *ci*; the needs in distribution *bi* which represents the need to distribute a product (*e.g.* mineral water is a product which is consumed more rapidly than cans of energy drink); the pressures *pi*, from the standardizing body, from distributors and/or by one/several Logistics Service Providers.

For the moment, we haven't solved the problem raised. Our plan was to know if there could be phases more flexible than the classical predation previously mentioned, in the adoption of standard(s) in the distribution channel. We obtain results which are more qualitative than quantitative.

6 Discusison

The distribution channel is the ideal place of the end-to-end control of supplies. It is also the place of emblematic collaboration with several stakeholders. However, the distribution channel should be the place where standardization would be unique and easy to implement for all stakeholders. Nonetheless, the process of traceability is not yet standardized in a unique manner, even if traceability can be achieved in spite of a choice of a standard *apparently* less developed technologically. This is what the analysis of the content of the players of the French distribution revealed. Mutualism-predation in the adoption of a standard more than another is what we could name coopetition of standard or coopetition of adoption.

This work has allowed us to bring three main results:

1. The relations of adoption of traceability standards on the distribution channel don't systematically follow the basic rules of rivalry between standards in other areas (*e.g.* LCD TV and plasma TV, etc.
2. The rule stating that standards should oppose and destroy each other so that only one prevails, is questioned in the sector of distribution,
3. Standards, even opposed, competing on the market, manage in the distribution channel to combine to co-create value (*e.g.* the 1D bar code has evolved by following the RFID tags design; or the articulation of the 2D and RFID standards gathered for a traceability project is feasible and operational, etc. This aspect of combination between "standards" is consistent with Hakansson and Waluszewki's hypothesis (2002), according to which certain solutions (*e.g.* standards) could/can interlock, even if this interlock is not generic.

The weakness of this work is that it doesn't define the functional responses associated with each term of the two differential equations. If we had done it, we could have studied the stability and the asymptotic stability of this dynamic model, and thus reconsider the questioning from (1981) on human stability. Above all, the action of modeling with an approach including the strategic calculation of players can be criticized. If *"the temptation of the resort to the theory of games is very strong, and is at the root of the popularization of the concept of coopetition of Nalebuff and Brandenburger (1996)"* says Le Roy (2007, p. 94), we can *"[…] doubt the interest of this approach as soon as we get out of the abstract economic thought and as we want to understand the real interactions between firms."*. If the fear from managers is sincere, it would be detrimental to leave the mathematical formalism aside to characterize the relations of adoption of a standard, of standards, provided that this formalism concerns the professional field of corporate strategy as closely as possible, which is our positioning here. Thus we model these coopetition behaviours in a managerial manner. The apprehension from Le Roy (2007) and from Yami and Le Roy (2010) does not show yet, since only a few works (Soubeyran and Weber, 2002; Lopez-Gomez and Molina-Meyer, 2007; Okura, 2007; Baski and Kleindorfer (2009); Zhang and Frazier (2011); Carfì and Schilirò (2012); Hu and Zheng (2014) refer to the coopetition of Nalebuff and Brandenburger (1996).

7 Conclusion

The diversity of the stakeholders, the successive steps in the distribution channel and its different technical and relational interfaces tend to manage the channel and to build micro-strategies on a daily basis. This trend pursues the idea that the success of innovation would be derived from relational dynamics between standards and the diversity of the stakeholders (Egyedi and Blind, 2008; van den Ende et al., 2012).

As a first result, we note that technological standards of traceability on the distribution channel can co-evolve together (Egyedi and Sherif, 2010) and that's what happens in the technological standards of traceability in the distribution channel. What we have noticed based on the verbatim transcripts is that the standards compete with one another (it was more the original vision) and now they "cooperate" with one another (in their technological, technical similarities and/or their technological inspirations and also thanks to other technological supports as WMSs, ERPs, smartphones, tablets, etc.). This interoperability of the standards (Blind and Gauch, 2009) and of the stakeholders in the distribution channel seems interesting and necessary to ensure the distribution of products to customers. Besides, Featherston et al. (2015) schematize (p. 8, fortcoming in *Technovation*) the difficulty of the implementation of interoperability between the different stakeholders and the standards along the particular channel ("synthetic biology"). The move from one standard to another only makes sense if it allows for the creation of advantages on the conversion costs and all other factors likely to tip the scale (de Vries et al., 2011; van de Kaa et al., 2011).

Our second result could continue the works started by de Vries et al. (2011), and de van Kaa et al. (2011). In the distribution channel, these other factors are altogether technical (facilitation of interconnections between players in the interface area), relational (facilitation of players at the level of relationships) and also the financial capacity of the adopter, the needs in the distribution of the product and the pressures for adoption by standardizers (here, GS1), by the other stakeholders (Manufacturers, Distributors and Logistics Service Providers, etc.).

In the vain of Grodal et al., (2015) who explored the situation of technologies' coevolution, we consider a need of new insights on standards' rivalry through competition, coexistence or coopetition.

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From Patent Hold-Up to Patent Hold-Out?

Marie Barani

CEA-Grenoble

marie.barani@gmail.com

Abstract: *Standardization is a process through which potential rivals cooperate to have the best technological solution adopted as the next standard. They pool together financial, human and material resources. Intellectual property rights, especially patents, are a powerful tool for them to recover investments made in the process and keep participating in it. However, to avoid abusive use of patents incorporated in de iure standards, companies contributing to the standard development have to comply with specific duties, amongst which making the technology essential to the standard available on Fair, Reasonable and Non-Discriminatory terms and conditions, i.e. the so-called (F)RAND commitment[1]. This commitment has been created to prevent patent hold-up from patent holders, which could force implementers to enter into disadvantageous license agreements. With the changes in the cellphone market in the last ten years, the content of this (F)RAND commitment has been challenged in courts and in front of antitrust and competition authorities. The question is whether this duty, set up to avoid hold-up, is not used by some implementers to engage in "hold-out" or "reverse patent hold-up strategies".*

1 Introduction

Standardization aims to define standards, which are technical rules. The process[2] is driven by the Word Trade Organization ("WTO")'s principles of transparency, openness, impartiality and consensus, effectiveness and relevance, coherence[3]. Firms that may compete at a later stage collaborate by pooling human, financial and/or technical resources to have the best technological solution adopted as next standard. Once the standard has been adopted, it is made public and available to anyone wishing to implement it, whether or not they are a member of the standard-setting organization that has developed the standard. Besides interoperability and compatibility, even between competing devices (EC regulation No. 1025/2012 on standardization), standards in telecommunications also guarantee high performance (Fraunhofer Study 2011).

For the reasons mentioned above, standards are considered as a tool encouraging innovation, technology dissemination and competition. Nonetheless, standardization is closely linked to intellectual property rights ("IPRs") and competition issues. Companies involved in standardization may hold patents. Unlike standards, which are available on an open and non-discriminatory basis, patents are exclusive rights granting their owners the power to block other parties from using the patented invention[4]. While both aim to encourage innovation,

[1] U.S. policies use the term RAND, while FRAND is preferred in Europe

[2] At least for standards d*e iure* developed or recognized by officially recognized organizations (while standards *de facto* are developed by one or more companies and gain market acceptance)

[3] TBT Committee, *Decision on Principles for the Development of International Standards, Guides and Recommendations with Relation to Articles 2, 5 and Annex 3 of the TBT Agreement,* 2000

[4] Cf. Article 28§1 TRIPS

patents and standards can appear incompatible at first sight. Even more so when patents are qualified as "standard-essential patents" ("SEPs"), as no technical alternative to these patents exist. Accordingly, each product or service implementing the standard without a license will therefore necessarily infringe the SEPs[5].

As a result, SEPs in principle confer their holders an increased market power by allowing them to control the standardization process and the downstream market (Shapiro 2001, Farrell et al. 2007). Consequently, in the absence of any safeguard, standardization could lead to behaviors impeding competition, as hold-up or royalty-stacking. Patent hold-up refers to the situation where SEP holders abuse their bargaining power to extract excessive royalty rates from their SEPs, potentially under the threat of an injunction. Such rates, if they are accepted by the implementer, may hamper the diffusion of the standard, as they could be financially burdensome and restrict access to the standard by implementers[6]. Royalty stacking occurs when the cumulative royalty rate for all the patents needed for the standard is excessive: even if each SEP holder demands a reasonable fee, due to the large numbers of SEPs to implement, the aggregate royalty rate for all SEPs exploited in the standard may reveal itself excessive and non-bearable (Lemley & Shapiro 2007).

Yet, SEPs play an important role in standardization. Companies holding SEPs are those contributing the most to the development of the standard (on contributors: cf. ABIresearch 2013, on SEP holders: cf. Fraunhofer Study 2011). Since standard-setting organizations ("SSOs") seek to "balance between the needs of standardization for public use in the field of telecommunications and the rights of the owners of IPR"[7], they have enacted IPR Policies to avoid anticompetitive behaviors while adequately rewarding SEP holders for their contribution to the standard. At the same time these policies shouldn't lead to a counter-abuse on the implementer's side.

One relevant part of the SSO's IPR Policies is the (F)RAND commitment. Through this commitment, SEP holders agree to share their SEPs accessible on (fair), reasonable and non-discriminatory terms and conditions to any party requiring such a license, instead of keeping the technology covered by such SEPs proprietary. The purpose is to prevent any patent hold-up.

The entrance of new players in the telecommunications market, some of which did not contribute their technologies to standardization but nevertheless manufacture standardized products[8], have been possible thanks to *de iure* standards[9], as they enhance competition and innovation. These changes have led to some challenging in worldwide litigations the suitability of the standardization process as it is currently working.

One issue arising from the recent worldwide litigations in the telecommunication sector is whether there is a real risk of "patent hold-up". Inversely, some players might be using the "(F)RAND commitment to engage in "reverse hold-up" (also called "hold-out"), by refusing or delaying negotiations and/or payment for the use of SEPs.

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[5] Cf. the definition of SEPs in Article 15.6 of ETSI IPR Policy and Article 6.2 IEEE's Bylaws

[6] The implementer will either have to accept rates "" far in excess of the patent holder's true contribution, which are similar to a tax on products incorporating innovation; or to postpone the sale of products/services incorporating the standard to avoid paying excessive fees or costly litigations (Lemley & Shapiro 2007)

[7] Cf. Article 3 ETSI IPR Policy

[8] Between 2005 and 2015, the former main manufacturers Nokia and Motorola have divested their handset business, and companies like Apple, Samsung, HTC, Huaweï, RIM, TCL, ZTE have entered the cellphone market, where they were previously not active

[9] *De iure* standards are developed or recognized by official organization. *De facto* standards are developed by one or more companies outside any standard-setting organization and gain market acceptance.

Both questions will be analyzed under U.S. and European IPR Policies, as SSOs like IEEE and ETSI have adopted the most litigated standards (GSM, UMTS, GPRS, Wi-Fi), which may also be the cornerstones for the Internet of Things ("IoT")[10]. This paper will focus on literature, case law and antitrust investigations in Europe and the United States("U.S."). The first section will examine the relationship between the (F)RAND commitment and the academic hold-up theory (I). The second part will examine how European and American judges and competition authorities address the question of hold-up (II). The third one will examine the potential transition from hold-up to hold-out (III).

2 The FRAND Commitment and Hold-Up

The content of the (F)RAND commitment has been challenged in courts (A) among others in order to mitigate the risk of hold-up as defined by Mark Lemley and Carl Shapiro (B).

2.1 The Content of the (F)RAND Commitment

SSOs usually don't interfere in the negotiations of a (F)RAND license, which they consider as a purely commercial matter between companies[11].

While standardization was first driven by firms competing but also cooperating at upstream level, to have the best technology adopted as next standard at downstream level, on the product market, the arrival of smartphones has changed the dynamic of the system: new companies (as Apple, HTC, TCL, ZTE, Huaweï) have entered the cellphone market, some of them initially not contributing to the standard development, while main contributors who were initially active both on the upstream development of standards and downstream cellphone market have divested their handset activity (e.g. Nokia, Motorola)[12].

The smartphone patent wars seem to suggest that upstream competition on the technology market and downstream competition on the end-device market between companies active on both sides have been replaced by a competition between contributors and implementers on a newly defined market, the SEP market. Litigations illustrate the tension between two different business perspectives: one that tries to reduce as much as possible licensing costs (implementers) and the other one that wants to maximize revenues on SEPs (contributors).

Some implementers claiming the necessity to obtain licenses on SEPs and complaining about a "too ambiguous" (F)RAND regime have initiated suits to specify the content of the (F)RAND commitment. Some SEP holders, facing years of unfruitful negotiations, have also sued manufacturers.

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[10] The IoT can be described as *a system where items in the physical world, and sensors within or attached to these items, are connected to the Internet via wireless and wired Internet connections. These sensors can use various types of local area connections such as RFID, NFC, Wi-Fi, Bluetooth, and Zigbee. Sensors can also have wide area connectivity such as GSM, GPRS, 3G, and LTE* (Lopez Research LLC 2013). The IoT will thus rely on current standards and evolution of current standards, therefore it is important to mitigate risks of abusive conducts as hold-up and hold-out

[11] Cf. 2.2 and 4.1 ETSI Guide on Intellectual Property Rights

[12] For data on contributors: cf. **ABIresearch report** (and Fraunhofer study on SEPs holders), where identified contributors are companies like Qualcomm, Ericsson, Nokia. Apple, HTC, Microsoft and TCL (who have argued in courts there is a patent hold-up) are not mentioned as contributors to the opposite of Samsung and Huaweï. They rather focus on developing products/services implementing the standards and seem less interested in standardization. They may acquire (e.g. acquisition of Nortel patent portfolio by Rockstar consortium including Apple) or develop SEPs however they are currently not the main contributors. When those companies are involved in litigations, they use the FRAND defence and don't often assess SEPs, rather "normal patents" and/or design patents (cf. litigations involving Apple, Microsoft or HTC). Cf. also 3GPP's website, with meeting reports and documents related to submitted contributions

As confirmed by judges, the (F)RAND commitment is not a license *per se*[13]. It only implies a duty for the SEP holder to enter into good faith negotiations with any potential licensee in order to determine (F)RAND terms and conditions for a license (ITC 2013). Accordingly, it has to be interpreted under contractual law. As any contractual negotiation, it may fail. Parties can then address their issues to an independent third party to have these (F)RAND terms and conditions specified[14].

When negotiations have been unsuccessful but the implementer is still using, hence infringing, the SEPs, and the parties go to court, the SEP holder will often demand to be granted an injunction to stop the infringing exploitation of his SEPs. In this case, the implementer will generally request the court to rule that this injunction breaches the (F)RAND commitment and constitutes an anticompetitive behavior intended to extract excessive royalty fees (patent hold-up). These claims are called a "FRAND defense".

But have patent hold-up concerns led to too strong restrictions on SEP holders' rights?

2.2 The Academic Hold-Up Theory

The theory of patent hold-up has been put forward by two American academics, Mark Lemley and Carl Shapiro (Lemley & Shapiro 2007).

They built their research papers on two cases for the 3G standards. Taking into account the number of declared SEPs and the royalty rates granted, they conclude that there is evidence of patent hold-up in both cases. They consequently advise to preclude SEP holders to be awarded injunctions to thwart the possibility of excessive royalty rates.

However, this study has been criticized on many points.

First, it implies that all bargaining power lies with the SEP holder. But some implementers may have a huge countervailing power due to their position on the downstream market and their financial strength (Geradin et al. 2007). In contractual negotiations, an implementer will probably use these characteristics to try to lower the rates, as missing a license with such a licensee would be strategically detrimental to the patent holder.

Second, it doesn't take into account the fact that SEP holders incur sunk costs they will not recover. Once these costs are invested, they are lost (Geradin et al. 2007). And as standardization is a long-term project, SEP holders are dependent on other players. If they misbehave, their technology will probably not be chosen for the next standard or the next version of the standard. Therefore, they have a clear incentive not to breach their (F)RAND commitment.

Third, it ignores the importance of cross-licensing and of portfolio-based licenses (Mallison 2014). These practices seem to have been quite relevant when companies were both active on upstream and downstream markets. Cross-licensing secures freedom to operate as both companies will mutually license their respective patents, and may imply a reduced licensing fee[15]. Portfolio licenses avoid to induce extra costs linked to the licensing of each patent separately and on a country per country basis (moreover in a context where companies are active on a worldwide basis). In the current framework, where participants are less vertically

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[13] Cf. Article 6.2 of IEEE's IPR Policy and case law as Rechtbank's-Gravenhage, *Philips v. SK Kassetten*, HA ZA 08-2522 en HA ZA 08-2524, March 17, 2010; Tribunale di Milano, Sezione Specializzata Proprieta' Industriale ed Intelletuale, *Samsung Electronics Co. Ltd. e Samsung Electronics Italia c. Apple Inc., Apple Italia S.R.L., Apple Retail Italia S.R.L., Apple Sales International,* R.G. 59734/2011.
[14] This appears to be consistent with the CJEU's approach in the case *Huaweï vs. ZTE,* §68.
[15] The royalties decrease because patents are "exchanged against patents"

and more horizontally integrated firms, competing on different markets and not on the whole value chain, these practices may have less practical relevance (Fraunhofer Study 2011).

Fourth, it is focused on one specific relationship, where SEP holder and implementers do not compete with each other (Shapiro 2010), however, this is not always the case [16].

Fifth, the authors don't provide any explanation on the figures they use and their origin. However, if we consider that around 75% of all SEPs to 3G are owned by only four firms (Geradin et al. 2007, Mallison 2014) and that the cumulative royalty yield on 2G, 3G and 4G for these four firms has been estimated for 2014 to approximatively 2.6% of mobile handset revenues (Mallison 2015)[17], assumptions of hold-up and royalty stacking may be less relevant.

Finally, patent hold-up is supposed to impede the adoption and diffusion of a standard. But standards like 3G and Wi-Fi have turned out to be fast and worldwide implemented technologies, creating a new market open to new actors. It doesn't look like SEPs have hampered the diffusion of the standards. If it were the case, prices of smartphones would increase and the number of entrants would decrease. Actually, the opposite is happening in the smartphone market: entrance of new actors and reduction of prices[18].

Do implementers then concretely face patent hold-up? The "(F)RAND defence" implicitly involves the question of hold-up. This claim of patent hold-up has been investigated under different laws and grounds in Europe and the United States.

Nevertheless, as some American judges have pointed out, it has to be proven. Arguing the existence of patent hold-up without any evidence to support the claim is not sufficient (ITC 2015, *CSIRO v. Cisco* 2015). An injunction request in itself is not as such a proof of hold-up.

How do European and American judicial, competition and antitrust authorities assess the situation of patent hold-up?

3 Hold-Up Under the Scrutiny of Courts and Competition Authorities in Europe and the USA

Patent hold-up has been addressed under different grounds in Europe (A) and the United States (B).

3.1 Hold-Up in Europe

Under European law, two different ways of assessing patent hold-up have been considered: one based on competition law and one on contract and patent law.

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[16] Some implementer-as Huaweï and Samsung-s are contributing to the standard development process (ABIresearch 2013). Furthermore, implementers and contributors may compete on other segments than either the standard development or the smartphone market (e.g. on the network infrastructure as it is the case between Ericsson, Nokia, Cisco, Huaweï).

[17] And the cumulative royalty yield for all SEPs holders reaches around 5% of mobile handset revenues (Mallison 2015)

[18] Standards related to mobile technology have been widely adopted, have a high penetration rate and bring about a consumer surplus of approximately $16.4 trillion. They rely on core technology developed by firms heavily investing in R&D (21% of revenue, around $1.8 trillion between 2009 and 2013), which enables the creation of a value chain with different business models, from manufacturers of components, devices and infrastructures, to content developers, software companies and startups at the end of the value chain. This value chain has generated almost $3.3 trillion in revenue in 2014 (The Boston Consulting Group 2015). Furthermore, prices for SEP reliant products are decreasing faster than for non-SEP reliant products (Galetovic et al. 2015)

The first one is linked to Article 102 TFEU and the abuse of a dominant position. It is on this ground that the European Commission ("EC") has investigated Samsung's and Motorola's behavior against Apple[19]. These investigations have led to the conclusion that SEP holders hold a dominant position on the SEP market, each SEP representing one market as such, where the SEP holder holds 100% of market shares. Therefore, demanding an injunction against a willing licensee expressing its intention to benefit from a FRAND license is an abuse of a dominant position. Nonetheless, the EC doesn't explain how it comes to the conclusion that each SEP constitute a single market in itself. This conclusion could seem a bit surprising as one single SEP is not sufficient to legally implement the standard. An implementer needs thus access to all SEPs, not just one. Additionally, a German regional court has stated in March 2015 that not all SEPs automatically confer a dominant position[20].

The second one depends on patent and contract law. Injunction is a legally enforceable way recognized to any IPR holder[21]. Notwithstanding the aforesaid, as SEP holders have committed to license their SEPs under FRAND terms and conditions, implementers imply from this FRAND commitment that the SEP holders are precluded to be granted an injunction. In case of judicial litigation, judges will determine whether the injunction request is a breach of the duty to negotiate in good faith, which is a contractual obligation. In Germany, under the *Orange Book Standard* case, any patent holder, even a SEP holder, is entitled to enforce its exclusive right against an infringer, unless the latter behaves as a true licensee and has made an unconditional FRAND offer that the SEP holder cannot reject[22]. The Dutch judges have a similar position. But they will further examine the parties' behavior during the negotiations to assess whether the SEP holder has breached his FRAND commitment. If the implementer has not sought any license from the SEP holder, the latter is in principle entitled to seek an injunction[23]. A similar decision has been issued in Italy[24]. In other countries, judges have rejected the injunction request, stating that monetary compensation is sufficient to indemnify the SEP holder[25]. Most of the European cases don't seem to lead to the determination of a FRAND royalty rate for two reasons. First, many cases are under summary proceedings, so the royalty rate will be determined at a later stage of the proceedings (e.g. in the case *Vringo v. ZTE,* ECHW 2014). Second, some of these cases (cases involving Apple, Samsung and Motorola/Google) have been relinquished (Chowdhry 2014, Rosenblatt et al. 2014).

In Europe, since the *Huaweï* case, the Court of Justice of the European Union ("CJEU") has established certain steps the SEP holder and the implementer will need to follow in order to respectively obtain or avoid an injunction. These steps have been recently endorsed by the Landgericht Düsseldorf (cf. below section III.B).

[19] European Commission, *Antitrust Procedure, Case AT.39939-Samsung-Enforcement of UMTS Standard Essential Patents,* 29 April 2014; European Commission*, Antitrust Procedure, Case AT.39985-Motorola-Enforcement of GPRS Standard Essential Patents,* 29 April 2014

[20] Landgericht Düsseldorf, *France Brevets v. HTC,* 4b O 140/13, 26 March 2015

[21] Articles 9 and 11 of directive 2004/48 of the European Parliament and of the Council of 29 April 2004 on the enforcement of Intellectual Property Rights

[22] Bundesgerichtshof, *Orange Book Standard,* KZR 39/06, May 6, 2009

[23] Rechtbank's Gravenhage, *Koninklijke Philips Electronics N.V. v. SK Kassetten GmbH & Co. KG,* 10 March 2011, KG ZA11-269, March 10, 2011

[24] Court of Genoa, *Koninklijke Philips Electronics N.V. v. Computer Support Italacard s.r.l.,* May 7, 2004

[25] Cf. France, Court of First Instance Paris, *Telefonaktiebolget LM Ericsson v. TCT Mobile Europe SAS and TCT Mobile International Ltd.*, No. 12/14922, November 29, 2013; United Kingdom, *Nokia Corp. v. IPCom GmbH & Co. KG,* [2012] EWHC 1446, and *Vringo Infrastructure Inc. and ZTE Limited*, [2015] ECHW 214

3.2 Hold-Up Under the Scrutiny of Courts and Antitrust Authorities in the US

In the U.S., the main focus has been put on the injunction request. Although the injunction is also an exclusive prerogative at the disposal of patent holders[26], since the *eBay v. MerckExchange* case, the award of an injunction has to follow a four factors test[27]. Judges often conclude that granting an injunction against a willing licensee would prejudice the public interest and that through the (F)RAND commitment, SEP holders implicitly acknowledge that monetary compensations are sufficient to indemnify them for the infringement (cf. e.g. *Apple v. Motorola*, 2012). The parties then try to get the royalty rate fixed following their interests. The discussion focuses on the basis and the rate of the royalty.

Two views oppose each other. On the one hand, the SEP holder, who has invested in standardization and supported sunk costs, needs both return on its investments and revenues to keep investing in the process. On the other hand, the implementer, who mainly gains revenues from the use of the standard and hence, from the SEPs, tries to reduce as much as possible the rate he will have to pay[28].

Therefore, some implementers argue that the basis of the rate should be the smallest patent-practicing unit (SSPU) implementing the SEP. This position, first advocated for non-SEP, is mostly adhered to by judges (*LaserDynamics Inc. v. Quanta Computer* 2012, *In Re Innovatio IP Venture* 2013). But the SSPU Doctrine doesn't consider the business models in presence: in telecommunications, it appears that most licenses are concluded "on end-device" basis (Stasik 2010, Teece & Sherry 2016). And courts never examine whether the standard, thus the SEPs it relies on, drives the demand for the product and confers to it properties it wouldn't have otherwise[29] (Teece & Sherry 2016). What if the device wouldn't be able to perform its specific functions without the exploitation of the patent? Components are generally incorporated into a product which needs these components to function properly. In case of multicomponent products, how do you calculate on which SSPU the fee relies (Teece & Sherry 2016, Petit 2016)? In addition to these issues, the SSPU doctrine overlooks the fact that the value of a patent depends on and differs following the product it is incorporated into (Teece & Sherry 2016, Petit 2016)? It also doesn't take into account the fact that the patented feature will increase the product's value in the eyes of the consumer (Petit 2016) due to properties conferred by the standard[30]. So the exclusion of the end product as a proper royalty basis is questionable.

Second, when we look at the determined royalties, courts cannot agree on a single rule to determine a (F)RAND royalty. How do judges fix a (F)RAND royalty? The use of the Georgia Pacific factors is questioned, because some judges even contest their application to "normal patents". Judge Robart has adapted the Georgia Pacific factors to SEPs in the case involving Microsoft and Motorola (*Microsoft Corp. vs. Motorola, Inc*. 2013), but judge Holderman has refused to apply these adapted Georgia Pacific factors in the case *Re Innovatio* (quoting *Ericsson v. D-Link* 2014).

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[26] 35.U.S.C. §283 Injunction and 19 U.S.C. §1337

[27] The plaintiff must demonstrate *(1) that it has suffered an irreparable injury; (2) that remedies available at law are inadequate to compensate for that injury; (3) that considering the balance of hardships between the plaintiff and defendant, a remedy in equity is warranted; and (4) that the public interest would not be disserved by a permanent injunction (eBay v. MerckExchange* 2007)

[28] It doesn't prevent implementers from acquiring, developing and asserting SEPs in litigations but many of them have (currently) a less large SEP portfolio than the main contributors, cf. footnote 12 *supra*

[29] Cf. Mallison (2013) about the difference of market demand, prices and functions between the iPod and the iPhone to value 3 and 4G standards (consumers are ready to pay more for 3G/4G and Wi-Fi standards)

[30] The product will have additional properties thanks to the standard (cf. footnote 29 *supra)*

Comparable licenses look like the most appropriate comparison mechanism. But they need to be qualified as “comparable”, which means related to SEPs, not intended to settle a litigation and not portfolio-based[31]. These criteria make it difficult to consider other licenses. Furthermore, licenses concluding a litigation should not be ruled out as the situation as such, the litigation, is comparable. And portfolio-based licenses, including SEPs and non-SEPs, should not be excluded if apportionment is still possible.

Third, patent pools rates are at first sight an interesting tool to determine (F)RAND fees, as they concern the same standard. But pool licenses join together many patents belonging to different holders that are licensed collectively. The rate often follows a numeric proportional rule and won’t differ according to the patents’ value or their technological contribution to the standard (Farrar & Lerner, 2006). If a SEP holder decides not to join a pool, he may estimate that the proposed rates for his SEPs don’t constitute an appropriate compensation[32].

Fourth, some courts in the US recall that the value of the SEPs should be the value parties would have agreed upon in hypothetical negotiations *ex ante* the incorporation of the SEP into the standard *(Microsoft Corp. vs. Motorola, Inc* 2013; *CSIRO v. Cisco* 2014). Two issues arise from this “hypothetical ex ante negotiation” valuation framework. Before the patent is included in the standard, it is not a SEP. So the patent holder is free to fix the value he wishes, without being curtailed by any (F)RAND commitment. This impacts the royalty rates on two ways. First, the negotiated value may be higher than once the standard includes the patent declared as SEP. Furthermore, the patent holder has not curtailed his exclusive power yet. He consequently remains entitled to refuse to license his patent. The second problem is whether the standard would still be as valuable without the incorporation of the invention covered by the SEPs. If the SEPs increase the value of the standard, why couldn’t SEP holders be fairly and adequately rewarded for it and for the value consumers grant to the standard developed by contributors[33].

Finally, a (F)RAND determination in court should also take into consideration the investments made by the SEP holder and his needs for a return on these investments to keep investing in the process. However, these elements are never analyzed. The risk is that if (F)RAND royalty rates don’t provide a sufficient return on the investments, the SEP holder may decide to stop participating in standardization and rather concentrate on a proprietary business model that may provide him with higher damages and royalty rates in case of infringement.

Concerning the examination of SEP holders’ conduct under the scrutiny of antitrust authorities in the United States, it can be dealt with on two legal grounds. First, the Sherman Act and the attempt to monopolize; second, Section 5 of the FTC Act, which addresses antitrust acts.

Section 2 of the Sherman Act has been examined by judges in judicial litigations, but has never really been endorsed as decisions mostly reject the injunction relief on the grounds of *eBay v. MerckExchange* and the public interest factor.

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[31] Rejection of proposed licenses: *In Re Innovatio IP Ventures LLC* 2013 because no negotiation within a (F)RAND context; same for the rejection of Symbol and Proxim licenses advanced by Motorola and rejection of RIM-Motorola license because applied to all Motorola’s portfolio and apportionment was difficult versus acceptance of ARM licenses whereas ARM business model is based on a license per component (*Microsoft Corp. vs. Motorola, Inc.* , 2013); rejection of Motorola license with VTech because ***not probative of a RAND rate because*** *part of a broader agreement that settled infringed claims licensed*” (*Microsoft Corp. vs. Motorola, Inc.* 2015) but **this case also concerned infringement claims and parties seeking to settle dispute through a license**; non rejection per se of comparable licenses in Ericsson v. D-Link (Fed. Circ)

[32] which has been confirmed in Europe by the Landgericht Düsseldorf , 31st March 2016, case 4a O 73/14

[33] Cf. above footnotes 29 and 30

Section 5 of the FTC Act has been scrutinized in FTC investigations. In two cases, the first against Bosch and the second against Google and Motorola Mobility, the FTC alleged that a SEP holder under a (F)RAND commitment infringes Section 5 of the FTC Act by seeking an injunction against a potential licensee[34].

Both in the United States and in Europe, competition authorities have thus ruled that demanding an injunction against a willing licensee constitutes an abusive conduct. But they have not analyzed the behavior of the so-called "willing licensee".

4 From Hold-Up to Hold-Out?

Implementers have based their claims against SEP holders on the hold-up theory. SEP holders retort that some implementers are engaged in "hold-out" or "reverse hold-up" strategy. Analyzing such an allegation requires first to define hold-out and to examine the implementers' conduct (A). The recent judgement of the ECJ in the *Huaweï v. ZTE* case may also provide a balance between both sides, each arguing the other one is behaving unfairly (B).

4.1 Patent Hold-Out and Implementers' Behavior

A licensee's willingness is a critical issue to evaluate the conduct of SEP holder under competition or antitrust law. If a potential licensee expresses its willingness to be granted a (F)RAND license but afterwards strategically delays the negotiations and refuses to pay a (F)RAND royalty rate, it may not be a true willing licensee (Ohlhauser, 2015). This behavior is the opposite of patent hold-up: it is called "patent hold-out" or "reverse hold-up". It can be strategically interesting for the licensee and detrimental to the SEP holder, for the reasons stated below.

First, the licensees who don't contribute to the standard development don't bear the R&D costs related thereto. They have also not shared the technology resulted from its R&D costs to the opposite of contributors.

Second, delaying the conclusion of a license agreement, and further dragging it through litigations and other proceedings postpones the payment of the royalty rate and prejudice the SEP holder, who won't be remunerated neither for the investments nor for the infringing use during months, if not years. Furthermore, the SEP holder will have to incur the litigation costs. This delaying strategy provides the potential licensee with a competitive advantage over a competitor who has paid a (F)RAND compensation (Sir Jacob, 2014).

Third, at worst, the implementer will be requested to pay a (F)RAND royalty rate sometimes only for a few number of (potentially infringed) patents, those in suit (while licensing practice is portfolio-based, cf. Section II.B. above). As an ITC judge summarizes it, the only risk for an implementer in not taking a (F)RAND license is to pay a (F)RAND fee (in the event that the patent is held valid, essential and infringed). It puts the risk of loss entirely on the side of the patent holder (ITC 2014).

Therefore, it appears fundamental not to assess only the SEP holder's behavior during negotiations, but also the implementer's one.

Just like hold-up, hold-out needs to be proven. Accordingly, demonstrating a "hold-out" requires to examine the "willing licensee's" behavior.

[34] U.S. Federal Trade Commission, *In the matter of Robert Bosch GmbH,* FTC File No.121-0081; U.S. Federal Trade Commission, *In the matter of Motorola Mobility and Google Inc.*, File No. 121-0120

Nevertheless, if we further analyze two famous cases in the United States and Europe, we may come to another conclusion.

The first one is the Motorola v. Apple case. In this case, neither the American judges nor the European Commission have considered Apple's behavior during the negotiations, which have been dragging on for 3 years without success. If Motorola's behavior was anticompetitive, it should nevertheless have been analyzed of Apple's conduct, which, according to German judges, didn't even make any "Orange Book Standard" compliant license offers in Germany till the 6th proposal, while at the same time complaining to the European Commission about Motorola's abusive behavior. The European Commission only stated what kind of conduct is not a sign of unwillingness[35]: it deems the fact that the implementer is "willing to negotiate a FRAND licence" as sufficient (European Commission, 2013). In the U.S., one judge involved in this litigation disagreed with her colleagues from the Federal Circuit court on the application of the eBay four-factor test and the qualification of Apple as a willing licensee[36]. Apple itself had claimed it would not pay any royalty exceeding $1 for any device and retained the right to appeal an award higher than this amount (*Apple Inc. v. Motorola Inc*. 2012)[37]. Qualifying a party as a "willing licensee" without assessing its conduct during negotiations doesn't seem really fair[38]: an implementer may say that it is "willing to be licensed the SEPs under (F)RAND terms and conditions" but then try to delay the negotiations and to postpone the moment where he will have to sign such a license and to pay the related rates. If the expression of willingness is the only requirement to be characterized as willing licensee, it may also induce abusive conducts from implementers.

The second case involves Apple and Samsung. Apple raised a (F)RAND defence against Samsung, after six months of unsuccessful negotiations, and the initiation of worldwide litigations against its competitor. It claimed Samsung's requested royalty rates and injunctions were abusive and qualified itself as a "willing licensee". However, as pointed out by the Advocate General in its opinion in the *Huaweï vs. ZTE* case, referring to the EC qualification of Apple as a "willing licensee" in its two investigations, "a mere willingness on the part of the infringer to negotiate in a highly vague and non-binding fashion cannot, in any circumstances, be sufficient to limit the SEP-holder's right to bring an action for a prohibitory injunction"[39]. Outside Europe, in South Korea, the court in Seoul concluded that Apple had not met the requirements to demonstrate it was a "willing licensee" because it had not requested to negotiate a license although it was aware of the existence of the SEPs[40].

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[35] European Commission, *Antitrust Procedure, Case AT.39985-Motorola-Enforcement of GPRS Standard Essential Patents*, 29 April 2014, §443 -conduct during the rate-setting proceedings before the court- and §454 **- refusal to acknowledge past infringement of all SEPs**. This last one is questionable: a refusal to acknowledge past infringement means that the potential infringer doesn't want to pay for the past exploitation of the patents he has benefited from. This situation is quite unfair for the patent holder and means a free usage of someone else's technologies, which is detrimental to the patent holder but also discriminatory towards the other licensees, who are paying for the exploitation of the patents.

[36] Rader, Chief Judge, dissenting-in-part (*Apple, Inc. and Next Software, Inc. v. Motorola Inc. and Motorola Mobility Inc.*, 2014)

[37] What if a judge had determined a (F)RAND rate higher than this amount?

[38] European Commission, *Antitrust Procedure, Case AT.39985-Motorola-Enforcement of GPRS Standard Essential Patents*, 29 April 2014, §111: "*Motorola and Apple have been engaged in licensing discussions, on and off, since 2007, following the termination of the Chi Mei Agreement by Motorola.* ***These discussions are not, however, addressed in this section as they do not affect the Commission's assessment of the abusive nature of Motorola's conduct*** *as established by this Decision*

[39] Paragraph 50 of the opinion of the Advocate General in the case *Huaweï Technologies Co. Ltd. v. ZTE Corp., ZTE Deutschland GmbH*, C-170/13, delivered on 20 November 2014

[40] Case: Samsung Electronics Co., Ltd. v. Apple Korea Ltd, Seoul Central District Court, 24 August 2012, Case no. 2011 GaHap 39552 (AIPPI Special Committee on Patents and Standards, 2014)

Next to the Korean Court's findings on Apple's (un)willingness, patent hold-out has been examined and confirmed in other courts outside Europe and the United States. First in India, in cases opposing Ericsson to local manufacturers[41]. As the cases evidence it, negotiations have lasted between 4 (for iBall) and 6 (for Intex) years, without any success. Manufacturers tried to delay the negotiations. They also claimed they were not aware of any Ericsson's SEPs while at the same time filing a complaint to the Indian Competition Authority against Ericsson for abuse of a dominant position. These complaints were initiated while the negotiations were still ongoing[42]. They underlined Ericsson was one of the main SEPs holders, accordingly any manufacturer should get a license from the Swedish company to ensure its freedom to operate on the market.

They didn't notify Ericsson the filing of these complaints. They informed it about the fact they also challenged the validity of the patents only once Ericsson started asserting its legal rights[43]. Indian courts ruled that they were behaving abusively, trying to delay the negotiations to avoid paying a (F)RAND royalty rate[44].

The High Court of New Delhi decided thus that the grant of an injunction was justified because in the absence of any injunction Ericsson would suffer irreparable loss and injury, as the defendant would keep on selling infringing devices without paying any royalty[45].

A similar situation confronted Ericsson to TCL in Brazil. Parties tried to negotiate a FRAND license agreement. Negotiations failed and Ericsson initiated proceedings against TCL. Meanwhile TCL filed an antitrust complaint to the Brazilian Competition Authority, arguing that Ericsson's injunction request was an anticompetitive conduct used to force TCL entering into unfair terms and conditions.

The Brazilian Competition Authority decided that Ericsson's conduct was not anticompetitive, being given the years of unfruitful negotiations and the number of other license agreements signed by Ericsson. It further points out that competition law is not concerned with excessive royalties (contrary to the Chinese Competition Authority who limited the fees Qualcomm is entitled to require from Chinese companies on his patents[46]), but only with the prevention of monopolization. It confirmed that seeking an injunction against an unwilling infringer committing hold-out is reasonable. Finally, it underlined that, as Ericsson was not active on TCL's market, it had no interest in not signing any license agreement with TCL. On the contrary, it was in its interest to have such a license agreement (Pereira 2015).

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[41] High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. Intex Technologies Limited*, March 13, 2015; High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. M/S Best IT World Private Limited (iBall),* 2nd September 2015

[42] They disclosed it once the Indian Competition Authority had already filed five revocation petitions in the Indian Patent Office, in The High Court of Delhi at New Delhi, *Telefnaktiebolaget LM Ericsson v. Intex Technologies Limited*, March 13, 2015

[43] High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. Intex Technologies Limited*, March 13, 2015, §106

[44] High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. M/S Best IT World Private Limited (iBall),* 2nd September 2015 §143 and following: *"This Court felt that **the defendant has not taken any step or shown any interest for the purpose of execution of the FRAND Agreement** as on the one hand the defendant is alleging that **it is not infringing the suit patents of the plaintiff** and on the other hand the defendant itself has filed the **complaint before the CCI wherein certain admissions of the rights of the plaintiff have been made**".* ; similarly in High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. Intex Technologies Limited*, March 13, 2015, §140 and 148

[45] High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. Intex Technologies Limited*, March 13, 2015; High Court of Delhi at New Delhi, *Telefonaktiebolaget LM Ericsson v. M/S Best IT World Private Limited (iBall),* 2nd September 2015

[46] Cf. King (2015)

These cases demonstrate that both parties' behavior may be abusive and should be examined to reach a balanced opinion. The CJEU has arrived to a similar conclusion in its recent ruling *Huawei v. ZTE.*

4.2 Balancing Both Sides: The CJEU Approach

In 2014, the Landgericht Düsseldorf asked a preliminary ruling to the CJEU. The court was indeed confronted with two different positions: on the one hand the *Orange Book Standard* case enabling SEP holders to enforce their exclusive right against any infringer, unless under two cumulative conditions stated above, and on the other the EC cases against Samsung and Motorola, where the EC decided that each SEP confers its holder a dominant position and that there is an abuse in requesting an injunction on SEPs in specific circumstances, i.e. the FRAND commitment and the so-called "willing licensee".

The Landgericht required the CJEU to define when there is an abuse of dominant position from the SEP holder side. The CJEU replied by defining where there is no abuse (Petit 2015). It has provided a sort of safe harbor for negotiations between a SEP holder and an implementer, with duties on both parties.

First, before bringing an infringement action, the SEP holder must inform the implementer it is infringing the patents and specify how. Second, if the implementer expresses its willingness to conclude a FRAND license, the SEP holder must make a proposal detailing how the royalty rate is calculated. If the implementer consider the proposal is not (F)RAND, it has to make a counter-proposal. In the event that the implementer doesn't diligently reply, the SEP holder is entitled to seek an injunction[47]. Each situation depends on a case by case factual analysis. This judgement has been endorsed by the same Landgericht in March 2016, when the court analyzed parties' behavior and granted the injunction. The judge considered that five months to express the willingness to negotiate a (F)RAND license was not diligent, and that a licensing proposal on one single SEP for one country doesn't comply with "recognized commercial practices" based on worldwide portfolio licenses, and would lead the SEP holder to expensive litigations country per country and patent per patent if accepted[48].

This case seems to contradict the amendments brought to the IEEE's IPR Policy.

In December 2014, the Board of the IEEE decided to specify the content of the "RAND commitment" in its IPR Policy. Besides requiring contributors to determine their SEP royalty rate on the smallest sealable patent practicing unit, the new IEEE Policy prevents contributors to request an injunction on their SEPs.

The IEEE, a neutral body, has decided to introduce these changes to clarify the duty of SEP holders. However, these modifications seem to be in line with arguments that have been publicly advocated by companies like Apple, Microsoft, Cisco, Intel[49], which claim that there is a risk of patent hold-up or that SEP holders are abusing their bargaining power. Furthermore, no clear evidence of a systemic patent hold-up has been demonstrated till now, apart from isolated cases such as the Motorola/Apple case. The changes of the IEEE's IPR Policy are thus not clearly and inconspicuously supported by the practice and evidences. They also ignore the WTO criteria of impartiality and consensus, as it seems that the neutral body

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[47] European Court of Justice of the European Union, *Huaweï Technologies Co. Ltd. v. ZTE Corp., ZTE Deutschland GmbH*, Case C-170/13, 16 July 2015, paragraph 77

[48] Landgericht Düsseldorf, 4a O 73/14, 31 March 2016

[49] For Apple and Microsoft, cf. their arguments in litigations against Motorola and Samsung. Concerning Cisco and Intel, cf. their responses to the EC's questionnaire on Patents and Standards: A modern Framework for Standardisation Involving Intellectual Property Rights, available at http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=7833

indirectly took position for the interests of one side, without considering the other side, but with the agreement and validation of the DOJ. The IEEE and the DOJ argued that these amendments are crucial to foster innovation and an effective development of standardization[50], even though the DOJ underlines that "*If a standard-setting process is biased in favor of one sets of interests,* ***there is a danger of anticompetitive effects and antitrust liability***". Notwithstanding these considerations, the main IEEE's contributors have declared they won't license under the new IEEE's IPR Policy (Decker & King 2015, Lloyd 2015). This declaration introduces uncertainty and complexity at three levels. First, for the same standard, SEPs may be licensed under two different IPR Policies (previous or new one), depending on the contributors. Second, the same problem may arise for next generations of standards implementing SEPs of former standards, and licensed under a previous IPR Policy, while SEPs only implemented by the new standard will be licensed under the new (or the previous) IPR Policy (Katznelson 2015). Third, ETSI has declared this new IEEE's Policy was incompatible with its own IPR Policy[51], which questions the cooperation between both SSOs.

The IEEE didn't even consider the fact that the ETSI introduced a waiver to the injunctive relief in 1993 and quickly removed this requirement from its IPR Policy (Sidak 2015). ETSI search for an IPR Policy in the beginning of the nineties led to an opposition between companies like Motorola, who wanted to keep the possibility to assert their IPRs, and European companies who were at that time less interested in IPRs (Bekkers et al. 2002). Different versions of an IPR policy were proposed, with different duties. Finally, after a complaint lodged against the "licensing by default" policy (which included four contentious and uncertain points), the ETSI chose the (F)RAND commitment based policy, without any specific duty related to injunction and royalty rate determination. And companies like Ericsson, Alcatel and Nokia have invested in IPRs, becoming important contributors (ABIresearch 2013; Bekkers et al. 2002).

So will these changes really benefit to the IEEE or do they risk lowering and weakening the position and role of this SSO in a context where standardization becomes increasingly important[52]?

5 Conclusion

SEPs play an important role in standardization. On the one hand, they represent technical contributions to the standard. On the other hand, they are a tool for their holders to get rewarded for these contributions. The (F)RAND commitment, set up to mitigate abusive conducts as patent hold-up and to provide a fair and adequate compensation to contributors, has been highly successful: standards as the GSM, UMTS and Wi-Fi have achieved a high and fast penetration rate.

However, litigations targeting to challenge the (F)RAND commitment put the equilibrium between contributors and implementers at risk. Only 33% of litigations between 2000 and 2013 in the United States concerns SEPs (Gupta & Snyder 2014). Litigating companies represent around 20 companies[53], while the ETSI has more than 800 members. Prices are

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[50] "By bringing greater clarity to the IEEE RAND Commitment, the Update has the **potential to facilitate and improve the IEEE-SA standards-setting process**" (D.O.J 2015)

[51] Cf. ETSI says IEEE's IPR policy is not compatible with its own. (2015, December 3).

[52] Cf. Europe Digital Single Market Strategy and the EU communication on ICT standardization priorities (standardization is a cornerstone of the Digital Single Market) and footnote 10 on the Internet of Things

[53] Essentially Apple, Ericsson, HTC, Huaweï, InterDigital,Microsoft, Motorola/Google, Nokia, Samsung, TCL, Vringo, ZTE, some of them not even being members of the ETSI

decreasing and new companies had no problems entering the cellphone market. No injunction has been effectively granted to any SEP holder either in Europe or in the United States. Evidences suggest therefore that there is no patent hold-up. It is however not so sure that we can reach the same conclusion with regards to patent hold-out. As implementers' conduct is never assessed under antitrust or competition law "because no market power is engaged"[54], the implementers could have a bargaining power they may abuse. Firms arguing there is a risk of hold-up are successful companies, some of them extracting high revenues from the use of the standard[55]. The changes inserted in the IEEE's Policy seem to be in the interest of (mainly American) companies which have advocated such positions. These changes breach the basic principles of standardization, i.e. impartiality and non-discrimination, by favoring one business model over the others. For these reasons, as well as for their incompatibility with ETSI's IPR Policy and the recent CJEU's ruling, they may hinder rather than foster innovation.

The discussion between patent hold-up and patent hold-out shows two tendencies: a fierce competition between SEP holders and newcomers through litigations, where it seems that newcomers try to redefine the rules in their advantages, and a shift of bargaining power from contributors to implementers (Froeb & Shor 2015). The threat of a FRAND defence used to strategically delay the conclusion of a license and the payment of (F)RAND fees may have a more detrimental effect than the threat of an injunction (which is almost never granted). In a context where new technical challenges like the Internet of Things and the Digital Single Market, depend on standardization, depriving SEP holders from incentives to innovate and to legally enforce their rights could prejudice innovation, competition and standardization, as abuses may arise from both sides, not solely from the SEP holders.

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[55] Apple got in 2015 more than 90% of smartphones profits with only 17% market shares (Elmer-DeWitt 2016), and ZTE gaining market shares (Einhorn 2015)

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Is the ISO/IEC OOXML Standard an International Standard under the TBT Agreement?

Andrea Barrios Villarreal

Graduate Institute of International Studies and Development
andrea.barrios@graduateinstitute.ch

Abstract: *The TBT Agreement requires that national regulations and standards are based on international standards; however, it fails to define the terms international standard and international standardizing body (ISB). As today, the Panel and the Appellate Body have put more emphasis on the requirement that a standard is adopted by an ISB than the process through which it is adopted to be considered as international for the TBT Agreement. This article shows, using the standardization process of the OOXML in the ISO/IEC JTC1 as an example, that an ISB may adopt standards that are not necessarily international. Hence, the importance that the panels and the Appellate Body use in forthcoming disputes follow the path opened in the US-Tuna II case in which the Appellate Body stated that there may be additional procedural conditions that must be met for a standard to be considered international for the TBT Agreement.*

1 Introduction

Countries use technical regulations and standards as instruments to achieve market and policy goals. They use them for example to diminish information asymmetry between producers and consumers or to provide the population with the newest medical devices and medicines. In the past years, the visibility of technical regulations and standards in trade has increased as a result of the tariff reduction achieved by the General Agreement on Tariffs and Trade (GATT). To avoid technical regulations being used as protectionist measures and creating unnecessary barriers to trade, parties to the GATT negotiated at the end of the 1970s, the Standards Code, which later became the Agreement on Technical Barriers to Trade (TBT) with the creation of the World Trade Organization (WTO). The TBT Agreement disciplines the preparation, adoption and application of technical regulations and standards; its main aim is to maintain a balance between the right of WTO Members to achieve legitimate goals through regulation and the disruptive and discriminatory effects this can have on trade. The Agreement establishes harmonization as one tool to achieve this balance. The TBT Agreement stipulates that when technical regulations and standards are required, Members shall use as a basis for them, the relevant international standards when they exist or their completion is imminent, unless they are ineffective or inappropriate for the fulfillment of their legitimate objectives. However, the Agreement fails to define what is or what characteristics a standard and a standardizing body shall comply in order to be considered as international for the TBT Agreement purposes. Having a clear definition of both terms is important as every day regulators and standardizers all over the world have to choose which of the several self-proclaimed ISBs they should play a full part in and what standards they should use as basis for their own technical regulations and standards. This is not an easy decision as they have to consider not only the market, economic and political consequences their choice will cause, but the fact that a technical regulation which creates more obstacles to trade than necessary could end in a trade dispute within the WTO.

The Dispute Settlement Body (DSB) of the WTO, conformed by Panels and the Appellate Body, has interpreted the concepts of international standard and international standardizing body (ISB).[1] As today, both Panels and the Appellate Body have put more emphasis on the characteristics of the body that adopts an international standard than on the procedure through which it is adopted in determining if a standard is an international standard for the purposes of the TBT Agreement. This paper argues that not all standards adopted by ISBs are international standards for the TBT Agreement as some of them fail to comply with the requirements imposed by the WTO. It also argues that in case of a dispute, the Panels and the Appellate Body should perform a procedural analysis of the standard under dispute. To support this argument it looks at the standards war that took place between the Open Office Document (ODF) and the Open Office XML (OOXML) standards, both of which were standardized by the ISO/IEC Joint Technical Committee 1 (JTC1) and it focuses on the standardization process of the latter to define if the OOXML can be considered as an international standard for the Agreement.

This paper is divided into four parts. The first part briefly explains the TBT Agreement requirement of harmonization of national regulations and standards with international standards and the findings of both the Panels and the Appellate Body in the case law. The second part describes the standardization process of the OOXML in the ISO/IEC JTC1, explaining first, the rules applicable to the process and second, how the actual process was carried out. The third part assesses the compliance of the standardization process with both the rules of the JTC1 and the requirements established in the TBT Agreement and by the TBT Committee. Finally, some concluding remarks are made.

2 The Regulation of Intentional Standardization under the TBT Agreement and the Existing Jurisprudence

Article 2.4 of the TBT Agreement requires that national technical regulations and standards are based on the relevant international standard except when it is an ineffective or inappropriate means for the fulfillment of the legitimate objectives pursued by WTO members.[2] However, the TBT Agreement does not have a definition of neither international standard nor ISB. The Appellate Body has interpreted some aspects of these two concepts, but so far, it has not had the opportunity to analyze head to toe the whole spectrum of international standardization, the body that develops the standard, the standard, and the procedure through it was developed.

In the *EC-Sardines* case there was an agreement among the parties that the Codex Alimentarius Commission is an ISB and that the standard under dispute, Codex Stan 94, was an international standard because it had been adopted by the Codex.[3] Because of this, both the Panel and the Appellate Body only focused on the relevance, effectiveness, and

[1] In the WTO when a trade dispute arise, one country adopts a trade policy measure or takes some action that one or more fellow-WTO Members considers to be breaking the WTO agreements it is for the DSB to settle the dispute. The first step, is consultations, to see if a friendly solution among the countries is achievable. If this fails, the second step is the establishment of a Panel experts to consider the case. Any of the parties to the dispute can appeal the findings of the Panel and it is for the Appellate Body, which is a permanent body, to review the Panel's findings. For more information see WTO webpage https://www.wto.org/english/thewto_e/whatis_e/tif_e/disp1_e.htm
[2] WTO, Agreement on Technical Barriers to Trade, article 2.4, 1994.
[3] The EC did argue that it was not the 'relevant' international standard but it never disputed its status as international standard. See Panel Report, *European Communities – Trade Description of Sardines, (EC-Sardines)* WT/DS231/R, 26 September 2002, para. 4.31.

appropriateness of Codex Stan 94 for the EC regulation.[4] In the *US-Tuna II* case the situation was the opposite, the Appellate Body analyzed some of the characteristics that a body should comply with to be considered as an ISB under the TBT Agreement, but since it found that the Agreement on the International Dolphin Conservation Program (AIDCP) was not open and therefore not an ISB, there was no need to look at the standard.[5] In the same case, the Appellate Body discussed "The Decision of the Committee on Principles for the Development of International Standards, Guides and Recommendations with Relation to Articles 2, 5 and Annex 3 of The Agreement" (hereinafter the Decision). The Decision which was adopted by the TBT Committee in 2000 establishes that transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and to address the concerns of developing countries are "principles and procedures [that] should be observed, when international standards, guides and recommendations (…) are elaborated".[6] The Appellate Body found that the Decision was a subsequent agreement among the parties,[7] because it had been adopted subsequently to the conclusion of the TBT Agreement; second, because it had been adopted by consensus by the Members of the TBT Committee which comprises all WTO Members; and finally, because when adopting the Decision Members had in mind "developing a better understanding of international standards within the Agreement […] to ensure the effective application of the Agreement […and] to clarify and strengthen the concept of international standards under the Agreement".[8]. The Decision therefore, informs the interpretation and application of a term or a provision to which it "bears specifically"[9] in the TBT Agreement. The Decision is therefore, "a further *authentic element of interpretation* to be taken into account together with the context".[10] Since the Decision bears specifically on the terms international standard and ISB in the TBT Agreement, it shall be used to inform their interpretation.

In the *EC-Sardines* case both the Panel and the Appellate Body left the status of international standard to be defined by the characteristics of the body that adopts the standard.[11] The analysis was composed of three steps: (1) the international standard at issue complies with the definition of standard; (2) the body that adopted the standard complies with the different components in the definition of ISB under the Agreement; and (3) the international standard is relevant for the technical regulation; and, effective and appropriate for the fulfillment of the legitimate objectives of the WTO Member. This analysis does not consider that it is possible that a standard that was adopted by a body that has relevant activities in standardization and that is open in a non-discriminatory manner to the relevant bodies of all WTO Members, is not an international standard. There are many reasons why a well-recognized ISB may develop standards that are not truly international from time to time; it might be that the

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[4] *Ibid*., paras. 431, 7.65 and 7.66.
[5] Appellate Body Report*, United States- Measures concerning the Importation, Marketing and Sale of Tuna and Tuna Products* (US- Tuna II), WT/DS381/AB/R, para 3.99.
[6] Committee on Technical Barriers to Trade, *Decisions and Recommendations Adopted by the WTO Committee on Technical Barriers to Trade Since 1 January 1995*, G/TBT/1/Rev.10, 9 June 2011 (11-2857), p. 46.
[7] *Ibid*.
[8] Appellate Body Report, *US- Tuna II*, paras. 371-372.
[9] Appellate Body Report, *US- Tuna II*, para. 372.
[10] See Appellate Body Report, *European Communities – Regime for the Importation, Sale and Distribution of Bananas. Second Recourse to Article 21.5 of the DSU by Ecuador, and Second Recourse to Article 21.5 of the DSU by the United States, WT/DS27/AB/RW/ECU and WT/DS27/AB/RW/USA, (EC-Bananas III cases (Article 21.5 Ecuador and United States)*), adopted 7 April 2008 and 19 May 2008 respectively, para 390 and Appellate Body Report, *United States — Measures Affecting the Production and Sale of Clove Cigarettes* (*US-Clove Cigarettes*), WT/DS406/AB/R, adopted 4 April 2012, para. 265.
[11] See Panel Report, *EC-Sardines*, paras. 7.63-7.66 and Appellate Body Report, *EC-Sardines* para. 221.

standard was not developed in a transparent manner, that not all the members received full and timely information, that not all the concerns of members and other interested parties were heard and addressed, that the interests of some members were favored, or that despite being a product of high importance for developing countries they were not included, etc.

The Appellate Body seems to have departed from this interpretation in the *US-Tuna II* case, when it stated that "there may be additional procedural conditions that have to be met for a standard to be considered 'international' for the TBT Agreement".[12] Following this suggestion, a new step should be added to the analysis that has been implemented so far. Before addressing if the international standard is relevant, it should be addressed if the standard is international *per se*, that is, if its 'internationality' not only comes from the characteristic of the body that adopts it, but also from the characteristics of the process through which it was developed and if it was respected. These 'additional procedural conditions' must include both the respect of the principles in the Decision and the respect of the rules and procedures established by ISBs for the development and adoption of international standards. Therefore, to be considered as an international standard under the TBT Agreement a standard should be adopted by an ISB, respect the development and adoption procedures of the ISB, and respect the principles in the Decision.

3 The Standardization of the OOXML Format in ISO/IEC JTC1

The ODF standard was adopted in 2005 by OASIS based on a specification elaborated by Sun Microsystems in 2000. ODF is "an open, XML-based file format specification for office applications"[13] which includes not only Microsoft Office applications which are the most widely used, but any other office applications such as Open Office and Polaris Office. The ODF is an open standard, which means that it is not a proprietary standard and it is vendor independent. According to T. M. Egyedi, in the context of government procurement, open standards are created to level the playing field in the market, increase standard-based competition among IT vendors and help governments acquire a better grip on the quality and rising costs of IT projects.[14] They also allow them to retrieve their content irrespective of possible future changes to the software.[15]

In the same year, OASIS which is an A-liaison organization of the JTC1,[16] presented to the joint committee the ODF specification for adoption under the Publicly Available Specification (PAS) rules.[17] The standardization process in the JTC1 went smoothly "because, at the time, the ODF format was not very well known (it was supported only in applications

[12] Appellate Body Report, *US-Tuna II*, para 3.53.
[13] See OASIS web page, https://www.oasis-open.org/committees/office/charter.php
[14] T. M. Egyedi, *To Select or Not? Dealing with Competing Standards in Public IT Procurement*, Delft University of Technology, 3 January 2012, p. 7.
[15] *Ibid*., p. 33.
[16] Liaisons-A organizations are those that make an effective contribution to the work of the TC or SC; they are given access to all relevant documentation and are invited to meetings. They may also nominate experts to participate. In order to be accepted as such, they need to be international or broadly based regional organizations working on or interested in similar or related fields to those of the TC or the SC they want to participate in. See ISO web page, http://www.iso.org/iso/about/organizations_in_liaison/organizations_in_liaison_details.htm?id=9657&LiaisonList=True and IEC web page, http://www.iec.ch/standardsdev/how/partners/
[17] PAS is a publication that responds to an urgent market need in areas of rapidly evolving technology, which represent either a consensus in an organization external to the ISO and the IEC or a consensus of experts within a WG. IEC web page, http://www.iec.ch/standardsdev/publications/pas.htm

with insignificant market share)".[18] Six months after the ODF was accepted by the JTC1, it was published as *the ISO/IEC 26300 — Open Document Format for Office Applications.*

Some experts have argued that the ODF standard was relatively immature, had some deficiencies, and missed some features that were vital to Microsoft, which explain why Microsoft could not switch into it.[19] Some other experts argue that ODF served Microsoft's software perfectly well, but what ODF was missing was Microsoft's support as it could threaten its preferential place in the market, particularly with governmental authorities.[20] At the same time, there was a movement of some governments towards software that conforms to ISO/IEC standards. Some governments such as the Massachusetts and the New York governments in the United States, the Brazilian federal government, the government of India, the European Commission and some of its members decided to use non-proprietary formats, because of economic and technological concerns and to eliminate the potential implications of giving a single company the capacity to limit access to state documents through proprietary formats and intellectual property rights.[21] If the access to old documents depends on the commercial software provider's backward compatibility, then the provider is in practice the owner of the digital content.[22] This movement and that ODF was an ISO/IEC standard produced a "strong reaction from Microsoft, which had an obvious economic stake in retaining the larger installed base of Office products".[23]

Microsoft had been working on the OOXML format since the beginning of the 2000s. OOXML was designed to capture all information stored in older Microsoft binary formats. In 2005, Microsoft submitted the OOXML to the European Computers Manufactures Association (ECMA) for standardization. The standardizing process in the ECMA took less than a year and according to an ECMA officer, the process went smoothly.[24] The standard, *ECMA 376 -Office Open XML File Format*, was adopted with 20 votes in favor, one against from IBM, and no abstentions in December of 2006.[25] In the same General Assembly, it was agreed to forward the OOXML standard to the JTC1 under the Fast Track Procedure.[26] Microsoft wanted its specification which already was the *de facto* standard to be formalized through an ISB.[27] The argument used by Microsoft and its supporters to initiate a second very similar and also XML-based standard in the JTC1 was that "the legacy of existing Microsoft office documents had not sufficiently been taken into account by ODF".[28]

3.1 The Rules of the Fast Track Process

ECMA submitted the OOXML standard under the Fast Track Process.[29] According to the Fast Track Process' rules, standards are presented at the enquiry stage; the preliminary, proposal,

[18] J. Kosek, "From the Office Document Format Battlefield", *IT PRO*, May-June 2008, p. 59.
[19] *Ibid.*
[20] For example T. M. Egyedi, A. Updegrove, and T. Bray.
[21] L. DeNardis and E. Tam, "Open Documents and Democracy: A Political Basis for Open Document Standards", *Indiana Journal Law and Technology*, vol. 5, 2009, p. 68.
[22] T. M. Egyedi, *To Select or Not?*, p. 33.
[23] L. DeNardis and E. Tam, "*Open Documents and Democracy",* p. 53.
[24] Interview with ECMA officer on September 8th, 2015. Notes available with the author.
[25] ECMA, *Minutes of the 92nd meeting of the ECMA General Assembly*, Zurich, Switzerland, 7 December 2006, Ecma/GA/2006/210, p. 10. Available with the author.
[26] *Ibid.*
[27] Interview with ECMA officer on September 8th, 2015. Notes available with the author.
[28] Egyedi, *To Select or Not?*, p. 33.
[29] In both the ISO and the IEC websites only the last version of the JTC1 Directives is publicly available which is not the one that was in force in 2008. The reconstruction of the Fast Track Procedures was made based on the appeal letter submitted by South Africa and in the R. Weir, "ISO/IEC JTC1 Revises Directives, Addresses

preparatory and committee stages are skipped. According to the rules in force at the time, the Fast Track Process began with a 30 day review period called the contradiction period, and then a 5 month ballot period. During the contradiction period, NSBs were able to "identify to the JTC1 Secretariat any perceived contradiction with other standards or approved projects of JTC1, ISO or IEC."[30] If no Member alleged a contradiction between the proposed standard and another JTC1, ISO or IEC existing standard, then the five-month ballot period started, but if a contradiction was alleged, the matter had to be addressed by the Information Technology Task Force (ITTF)[31] and the JTC1 Secretariat in no more than three months before voting could begin. The ITTF and the JTC1 had to consult with the proposer of the fast track, the NSB(s) that raised the claim and others as they deemed necessary. Also, a meeting of these parties, open to all NSBs, could be convened if required. If the ITTF and the JTC1 resolution did not require any changes in the document, then the five-month ballots started immediately. The JTC1 was under the obligation to circulate the comments received during the contradiction phase and the resolution of the ITTF and the JTC1 to the NSBs. When the ballots were returned, for the draft standard to become a JTC1 standard it was necessary that at least two-thirds of the P-Members voted in favor and that no more than one-quarter of the total votes cast were negative. If the draft standard failed to get the required votes, in no less than two and a half months a Ballot Resolution Meeting (BRM) could be convened. During the BRM decisions had to be made by consensus and if a vote was unavoidable, the vote was taken according to normal JTC1 procedures. Clause 9.4 of the JTC1 Supplement stated that "questions are decided by the majority of the votes cast at the meeting by P-Members expressing their approval or disapproval".[32] If the NSBs agreed on a text during the BRM, the editor of the draft standard compiled all the approved modifications into a new draft. Delegates reported back to their NSBs and each of the NSBs which voted in the first fast-track ballot had 30 days to decide whether they wanted to approve the revised text, the approved on the BRM, or not. This second ballot was done on the document that was circulated before the BRM and not on the modified version resulting from the BRM, as this last document might not have been circulated when the ballot took place. In no more than one month, after the BRM, the SC Secretariat had to distribute the final report and the final draft standard in case of acceptance. If it was impossible to agree on a text, the proposal had failed and the procedure was terminated.

3.2 The Standardization of the OOXML under the Fast Track Process

The standardization of the OOXML in the JTC1 started with the contradiction phase, during which NSBs had a month to review the lengthy document, more than 6,000 pages, that was presented by ECMA. Even with the heavy workload, the JTC1 received comments from twenty NSBs.[33] As noted by A. Updegrove, it was not only that the number of comments was large but also that twenty responses was greater than the total number of national bodies that often vote on a draft standard.[34] In response to these comments, ECMA submitted a proposed

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OOXML Abuse", www.robweir.com, July 7th, 2010, which explains the modifications that the version that was in force in 2008 suffered in 2010.

[30] SABS, *Appeal from the South African national body regarding the outcome of the fast track processing of DIS2 9500 Office Open XML*, 22 May, 2008.

[31] The ITTF is a body jointly formed by ISO and IEC responsible for the planning and coordination of the work of JTC1.

[32] SABS, *Appeal from the South African national body.*

[33] These countries were: Australia, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Italy, Japan, Kenya, Malaysia, Netherlands, Norway, Romania, Singapore, Sweden and the UK.

[34] A. Updegrove, "The Contradictory Nature of OOXML (Part II)- 19 Nations [make that 20] Respond", *The Standards Blog*, February 06, 2007.

Disposition of Comments Report that was close to 2,300 pages. Then, the draft standards with some clarifications from ECMA and the Disposition of Comments Report were circulated by the SC 34 Secretariat for NSBs to vote on its adoption in a 5 month period. The results of the September 2007 ballot were: of the 41 P-Members of the SC, only 53 per cent of the 66.66 percent required voted in favor and 26 per cent of the total votes were cast negatively.[35] Both positive and negative votes, the latter which necessarily needed to be accompanied by comments, resulted in more than 3,500 comments.

In order to address these comments, which ECMA had reduced to 1,100 recommendations as some of the comments were repetitive, the SC Secretariat convened for a BRM that was held in Geneva between the 25th and 29th of February, 2008. The meeting was attended by 120 delegates from 33 NSBs.[36] During the meeting and in order to address the large amount of comments, *ad hoc* groups were created and a decision was reached through a mix of consensus and voting. However, because in a week it was impossible to solve the 1,100 issues, three proposals were made: the first one, to accept ECMA's recommendations without modification; the second one, to reject ECMA's recommendations and leave the drafts unchanged on the unresolved matters; and the third one, to conduct a paper ballot on each recommendation. The first option was regarded as the most feasible. Delegates decided with a "majority of 29 votes in favor, that the paper ballot would be conducted, and a simple majority of Approvals, without counting Abstentions, would mean approval" of this option.[37] The paper ballot was only over the ECMA Responses that had not been explicitly addressed in other ways during the meeting, around eighty per cent. The draft standard was adopted with the recommendations made by ECMA by a positive vote of only six of the thirty members, four votes against and twenty abstentions.[38 39]

After the BRM, NSBs had 30 days to reconsider their vote. The draft standard was adopted with 75 per cent of positive votes from P-Members and only 14 per cent of all negative votes. The draft standard with ECMA's recommendations had not yet been distributed to the NSBs when this second ballot took place, therefore their vote was based on the first draft standard and on the reports of the delegates that attended the BRM, for those NSBs that had sent delegates.[40] The ISO/IEC DIS 29500, *Information technology – Office Open XML file formats*, was finally adopted in April 2008.

4 The Appeals to the Adoption of ISO/IEC 29500

Some NSBs were discontent with the process and appealed the adoption of the standard. According to the ISO/IEC Directives and the JTC1 Directives in force at the time, NSBs that participate as P-Members were able to make an appeal within 60 days after the decision had been made. The appeal has to be "based on actions or inactions not in accordance with the

[35] ISO, "*Ballot resolution meeting addresses comments of draft ISO/IEC29500 standard"*, *ISO News,* 5 March 2008.

[36] P. Sayer, "Debate on OOXML standard continues behind closed doors", *Info World*, February 27, 2008 and ISO, "Ballot resolution meeting addresses".

[37] A. Christofides, Some clarifications on the OOXML Ballot Resolution meeting, *ΕΜΠ - Τυποποίηση Τεχνολογίας Πληροφορικής*, July 11, 2011.

[38] P. Sayer, "Changes to OOXML draft standard waved through", *Info World*, February 29, 2008 and M. Chernoff, "ISO approval: A good process gone bad", *Red Hat Magazine,* 24 March 2008.

[39] ISO's official information says that the BRM was attended by 33 Members, but since the meeting attendance list or minutes are not publicly available, it is unknown, why 3 NSBs did not vote or if the information provided by A. Christofides, is accurate, though the source is trustable, the technical University of Athens.

[40] ISO, "ISO/IEC DIS 29500 receives necessary votes for approval as an International Standard", *ISO News,* 2 April 2008.

ISO or IEC Statutes, the ISO/IEC Directives or not in the best interest of international trade and commerce" and if "questions of principle are involved; the content of a draft may be detrimental to the reputation of ISO or IEC; or the point giving rise to objection was known to JTC1 or SC during earlier discussions".[41] The Secretaries of ISO and the IEC had one month to examine the appeal and try to reach a compromise with the NSBs. If that failed, the appeal was passed to the Technical Management Board (TMB) and the Standardization Management Board (SMB)of the ISO and the IEC, respectively. [42]

The NSBs from India, Brazil, South Africa and Venezuela filed appeals. The South African appeal was "based on the procedures followed before and during the BRM" and which were not in accordance with ISO/IEC JTC1 Directives, 5th Edition (which were in force at the time). First, according to SABS, the South African NSB, although various NSBs raised contradictions during the contradiction phase, the JTC1 Secretariat and the ITTF did not address them properly. They failed to inform the other NSBs "about the alleged contradictions but were [only] informed in the Head of Delegations meeting immediately prior to the BRM, that any issues of contradictions raised during the BRM would be ruled out of order by the BRM Chairman".[43] Despite this, "a number of NSBs continued to raise contradictions both in their written comments and during the BRM, [which made clear…] that a meeting of parties, as envisaged in the Directives was indeed a necessity" and the JTC1 and ITTF Secretariat failed to convene "a meeting of these parties open to all NSBs".[44] Second, clause 13.8 of the JTC1 Directives required that during the BRM decisions were 'reached preferably by consensus' and that if 'vote [was] unavoidable [it] should be taken according to normal JTC1 procedures'. SABS argued that "since only 67 of the 1027 responses by ECMA were discussed, the processes used to 'approve' the remaining responses by voting were questionable and did nothing to promote consensus, but simply 'approved' ECMA's attempt to improve the quality of the standard" and that although some consensus was achieved on some of the ECMA responses in the *ad hoc* meetings, "the decision to resort to blanket voting on all issued not resolved during the discussion was procedurally flawed".[45] Third, with regards to what constituted 'normal procedures', South Africa argued that clause 9.14 of the Directives stated that 'questions are decided by a majority of the votes cast at the meeting by P-Members but that because many of the NSB present were not P-Members, the actual voting was conducted according to clause 9.5 Combined Voting Procedure which is 'the voting procedure which uses simultaneous voting by the P-Members for JTC1 and by all ISO Member Bodies and IEC national committees;' which was "incorrect since the voting during the BRM was not a letter ballot".[46] Finally, SABS also argued that JTC1 Directives also requested that 'in no more than a month after the BRM, the SC Secretariat shall distribute the

[41] SABS, *Appeal from the South African national body.*

[42] The TMB is composed by 15 NSBs from which 6 are permanent seats allocated to the NSBs that contribute the most to the organization. The rest are not open to all Full Members, but only to those that play a leadership role within the organization. The TMB holds the agenda power in the ISO; it approves the establishment and dissolution of TCs; it approves the strategic planning, programmes of work and monitors TCs activities; it appoints the chairs of the TCs and allocates or re-allocates secretariats and manage the appeals. The SMB also has 15 members, 6 of which are also permanent seats allocated to the National Committee that contribute the most to the organization. The SMB is responsible for the management and supervision of the IEC's standards work. It is responsible for the establishing, margining and splitting TCs as well as for allocating TCs secretariats to NCs and appointing the chairman for each TC upon nomination by the TC secretariat. ISO, *ISO Statutes*, seventeenth edition, 2013, articles 9 and 10 and *ISO/IEC Directives and the Consolidated ISO Supplement,* article 1.1 and IEC, *Statutes and Rules of Procedure*, 2001 edition, Appendix 2.

[43] *Ibid.*

[44] *Ibid.*

[45] *Ibid.*

[46] *Ibid.*

final report of the meeting and the final draft standard text' and that until the 22nd of May 2008 "neither (…) had been circulated [and] there was no indication of when the final draft standard should be expected".[47] In conclusion, SABS challenged "the validity of a final vote that was based upon inadequate information resulting from a poorly conducted BRM and the validity of the process [… which had also] harmed the reputation of both ISO and IEC".[48] Apparently, the other appeals were also based on the rushed procedures and the delayed publication.[49]

he appeals did not proceed neither in the TMB nor the SMB as they failed to gain the support of two-thirds of its members.[50] The ISO stated that "the processing of the ISO/IEC DIS 29500 project has been conducted in conformity with the ISO/IEC JTC1 Directives, with Decisions determined by the votes expressed by the relevant ISO and IEC national bodies under their own responsibility" and that the final text was not available on time "does not justify an appeal because the vote is necessarily based on the draft text [the one rejected in September], which was available to all voters".[51]

5 Assessment of the ISO/IEC 29500 as an international standard for the TBT Agreement purposes.

In order to determine if the ISO/IEC 29500 standard can be considered an international standard for the TBT Agreement purposes, several aspects should be taken into consideration: the alleged irregularities in the NSBs, the alleged irregularities within the JTC1 process and the compliance with the definition of international standard and the principles in the Decision.

First, there were allegations that Microsoft encouraged new countries to join the JTC1 or to upgrade their status from O to P-Member and to vote in favor of its adoption.[52]. There was a sudden incorporation of 36 NSBs (11 P- Members and 25 O-Members) to the JTC1 just in time for the OOXML discussion and voting. This was regarded with suspiciousness because according to M. Chernoff, while 90 per cent of the new members voted in favor of the OOXML proposal, only 36 per cent of the original membership voted in favor.[53] Also, voting irregularities were reported in some NSBs, according to J. Robie, in nearly one-quarter of P-Members that voted in favor.[54] In Switzerland, the Free Software Foundation Europe (FSFE) and the Swiss Internet User Group (SIUG) raised some concerns with regards to a conflict of interest in the Swiss mirror committee as its chair was also the Secretary General of ECMA, and although he had moved the discussions from the mirror TC to the mirror SC, this was not sufficient as he was still the chair of the parent committee and he had selected the chair of the mirror subcommittee.[55] Also, according to the FSFE, the chair of the mirror SC rejected any

[47] *Ibid.*
[48] *Ibid*.
[49] See P. Sayer, "India and Brazil File Appeals against OOXML Standardization", *IDG News Service*, May 30, 2008.
[50] ISO, "ISO and IEC Members give go ahead on ISO/IEC DIS 29500", *ISO News*, 15 August 2008 and E. Montalbano, "ISO, IEC rejects appeals, approve OOXML spec", *InfoWorld*, August 15, 2008.
[51] R. Paul, "ISO leadership encourages rejection of OOXML appeal", *Ars Technica,* July 10, 2008.
[52] M. Chernoff, "ISO approval: A good process gone bad", *Red Hat Magazine,* 24 March 2008.
[53] M. Chernoff, *ISO approval*.
[54] J. Robie, "OOXML Approved by ISO: What Next?" *Red Hat Magazine*, 10 April, 2008.
[55] FSFE, *FSFE formal objection to the recent UK14 meeting,* 13 August 2007 *and SIUG*, letter to the SNV, 14 August, 2007.
An officer from ECMA recognized that there was a conflict of interest, but he also stated that there were not many options, there are not many willing people who also have the technical knowledge to chair a mirror TC. Interview with an ECMA officer, the 8th September 2015. Notes available with the author.

discussion on the market situation and Microsoft's monopolistic situation in Europe and the United States, on the grounds that the JTC1 does not have authority to research monopoly practices. FSFE as well as SIUG objected when the chair's recommendation for the SNV to vote in favor of the OOXML was rejected by a 7 to 4 majority for 'disapprove with comments', the chair disregarded the results.[56] According to an ECMA officer in the Swiss national committee, there was no corruption, but there might have been an expectation of some participants to obtain Microsoft's contracts.[57] In Norway, 13 of the 23 members of Norway's mirror committee resigned in protest over procedural irregularities in the approval process of the OOXML standard. Norway's NSB reversed its vote for disapproval "despite strong opposition to the format by a majority of its members". According to G. Isene, member of the Norwegian mirror committee,[58] "of the 24 members attending, 19 disapproved, 5 approved" but "the administration staff decided that Norway wanted to approve OOXML as an ISO Standard".[59] Standards Norway argued that the "approval was based on the outcome of a public inquiry in which the majority of the responses it received encouraged support of OOXML [but] it also admitted that a significant number of those responses were identical submissions authored by Microsoft".[60]

Accusations were also made that Microsoft was pressuring NSBs to support the standard. In Sweden an email in which Microsoft Sweden offered extra marketing contributions to its business partners to encourage them to vote in favor of the adoption of OOXML was made public. The email stated "that its partners were expected to register a vote with SIS and take part in the meeting to vote yes for Office Open XML (…) and were also requested to attend more meetings after the vote in order to prove their sincere participation".[61] Since there was a registration fee of 15,000 Swedish crowns to participate in the mirror committee, "Microsoft offered marketing contributions and extra support in the form of Microsoft resources" in exchange.[62] This led to a large number of companies deciding last minute to take part in the voting and turned the table in Microsoft's favor. Later, the Swedish NSB decided to invalidate the vote in favor of the OOXML. This decision was not based on the accusations that Microsoft had encouraged participation and voting of its business partners, but after evidence was presented that one of the participants in the Working Group had participated in the vote with more than one vote.[63] According to an ECMA officer, Microsoft understood the political game in the ISO and the IEC and it went to all NSBs looking for support.[64]

There were also several irregularities within the JTC1 standardization process which went against the purposes of the JTC1 and the ISO and the IEC. First, it seems that the contradiction phase was poorly managed as 20 NSBs expressed concerns, these were not made of the knowledge of other NSBs until very late in the process and the JTC1 Secretariat decided not to convene a meeting even though with a number of comments received, it seemed appropriate. Also, although the JTC1 does not specify a time frame limitation for a BRM, it decided to have a one-week meeting which as stressed by some delegates, was

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[56] FSFE, *FSFE formal objection to the recent UK14 meeting*.
[57] Interview with an ECMA officer, the 8th September 2015. Notes available with the author.
[58] http://it-nytt.no/norge-kan-avgjore-ooxml-striden/
[59] K. Fiveash, "OOXML approved as international standard?", *The Channel*, 3131st March, 2008.
[60] R. Paul, "Norwegian standards body implodes over OOXML controversy, *Ars Technia*, October 3, 2008.
[61] D. Goldberg, "Microsoft pressed partners in Sweden to vote for OOXML", *The Washington Post*, August 30, 2007.
[62] *Ibid.*
[63] Swedish Standard Institute, Office Open XML-SIS oglitigförklarar omröstingen, 30 August, 2007. The translation of the letter to English is available with the author.
[64] Interview with an ECMA officer, September 8th, 2015. Notes available with the author.

clearly not enough to review a 6,600 pages standard plus a 2,300 response document of ECMA and more than 1,000 comments.[65] Similarly, it seems that during the BRM the 'normal decision-making process' was not followed; and the final standard was published later than the month that the JTC1 Directives marked as a deadline. Apparently, when the standard was finally published, some of the changes that were agreed on in the BRM were not even made. Second, The JTC1 Directives, 5th Edition, established in its General Provision that "a purpose of IT standardization is to ensure that products available in the marketplace have characteristics of interoperability, portability and cultural and linguistic adaptability" and the JTC1 accepts "the responsibility (…) to produce the key IT standards (…) to facilitate practical, timely and cost-effective interoperability, consistent with market requirements and current technologies".[66] SIUG and FSFE are right at pointing out that 'market' refers to a situation in which "there are several vendors in competition with each other and [that] in this context, 'market requirements' refers to what these vendors need to provide in order to be considered by their potential customers as a vendor capable of meeting their needs".[67] OOXML does not comply with this as it is aimed to standardize the product of a sole vendor; it provides "interoperability within among those vendor's products, but not interoperability between the products of different competing vendors".[68] Furthermore, since the standardization of the OOXML provides a tool to Microsoft that favors its predominant, almost monopolistic, position in the market, the international standard is "not in the best interests of international trade and commerce", but in the best interest of one company.[69] Although it could be argued that a large number of consumers will benefit as well, in the long run strengthening Microsoft's monopoly position reduce consumers' choices and elevates their exit cost. Furthermore, monopolistic practices are market failure, they create obstacles to trade as they prevent other vendors from entering the market, and they increase prices for consumers and discourage innovation, which can negatively affect growth.[70] Therefore, in the standardization process of the OOXML there were 'actions and inactions not in accordance with the ISO/IEC Directives, not in the best interest of international trade and commerce' and 'questions of principles were involved, the content of the draft was detrimental to the reputation of both the ISO and the IEC', and therefore, the appeal should have had proceed. The fact that it did not, seems to violate the ISO and the IEC procedures.

With regards to the compliance with the TBT Agreement and the principles in the Decision, it can be stated since the OOXML standard was adopted by a conjoint TC of the ISO and the IEC it complies with the requirement of being adopted by an ISB. Also, the standardization complied with the openness principle as it was open to all the Full Members of both the ISO and the IEC. Proof of this is seen in the number of NSBs that decided to join the SC 34 at the last minute. However, compliance with the transparency principle is questionable as Members were not made aware that 20 NSBs had presented comments during the contradiction phase until very late in the process. With regards to the impartiality principle, there was no compliance. The balance of stakeholders was left to the national bodies, which led to complaints of bias, like in Australia where the delegation had a Microsoft expert and no other views were represented;[71] or cases in which the staff of the NSB made the decision without

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[65] M. Chernoff, *ISO approval.*

[66] SABS, *Appeal from the South African national body.*

[67] FSFE, *FSFE formal objection to the recent UK14 meeting,* 13 August 2007 *and SIUG*, letter to the SNV, 14 August, 2007

[68] *Ibid*.

[69] SABS, *Appeal from the South African national body.*

[70] See N.G. Mankiew, *Principles of Microeconomics,* 2nd Edition, 2001, Pp. 315- 347.

[71] A. Hendry, "The OOXML BRM and Australia: What happens next", Computerworld, 26 February, 2008.

considering the position of its experts.[72] In order to comply with the impartiality principle, the Decision states that "the standard development process will not give privilege to, or favor the interests of, a particular supplier/s, country/ies or region/s."[73] In this case, it was clear that the interest of a particular supplier, Microsoft, were privileged. Microsoft was able to capture the process, and apparently there were not enough padlocks to prevent it, neither at the national nor at the ISB level.

There were several incidents that show that the process was not consensus based. First, twenty NSBs noted that there were some contradictions with ODF standard (contradiction phase) which apparently were not properly managed. Second, the draft standard was rejected in the first ballot and four NSBs appealed the process. Third, in the BRM the standard was adopted with more abstentions than votes. Besides, the IITF and the Secretariat of the SC 34 failed to convene a meeting before the first ballot took place; this does not reflect that "procedures were established to seek to take into account the views of all parties concerned."[74] That the BRM lasted for one week, which considering the size and complexity of the standard was not enough time, does show that the procedures established "to reconcile any conflicting arguments" were not appropriate. [75]

The Decision also states, "international standards (…) should not distort the global market, have adverse effects on fair competition, or stifle innovation and technological development".[76] Creating a standard for a sole vendor, which despites Microsoft's assurance of an Open Specification Promise still has some proprietary issues, seemingly distort the market.[77] The OOXML standard has potential "adverse effects on fair competition" because it helps Microsoft to secure its monopolistic position in the market and "stifle innovation and technological development" as it also creates vendor lock-in.[78] Innovation can be affected because according to T. Bray there are a lot of mistakes in the ISO/IEC 29500, which translate, among other things, into interoperability problems. Finally, the adoption of an international standard creates expectations among producers, suppliers and developers that products will conform to it. There have been accusations that Microsoft's products do not comply with the ISO/IEC 29500 standard and they are using "the very format the global community *rejected* in September 2007 […and that] Microsoft [is] behaving as if the JTC 1 standardization process never happened".[79] The lack of fulfillment of the market expectations can also create distortions in it.

The standard is neither coherent, not only because it does not "avoid duplication of, or overlap with" another standard that was also adopted by the JTC1, but also because it does not "avoid the duplication of conflicting international standards".[80] The ODF and the OOXML are

[72] According to an interview with a delegate to the BRM "there were some problems with national delegations positions, particularly those of the US, over-rode the private opinions of some of their experts. Even in the UK we had problems as there were two sets of "experts" who had different stances on the acceptability of various aspects of the proposal. The UK strongly pressed for interworkability of standards". Complete information available with the author.
[73] Committee on TBT, *Decisions and Recommendations*, p. 47.
[74] *Ibid*.
[75] *Ibid.*
[76] *Ibid*., p. 48.
[77] According to T. Bray "for a variety of OOXML elements you can attach an attribute like this target : "_media" which is Windows specific. That is, it is still necessary to have additional information from Microsoft to "implement full backward compatibility and conversion". See T. Bray, "On OOXML", *tbray.org* and FSFE, "Six questions to national standards bodies", *www.fsfeurope.org*.
[78] Committee on TBT, *Decisions and Recommendations*, p. 48.
[79] A. Brown, "Microsoft Fails the Standards Test", http://www.adjb.net/ 31 March 2010.
[80] Committee on TBT, *Decisions and Recommendations*, p. 48.

competing standards, i.e., they are functionally equivalent and/or largely overlapping standards but not fully compatible. A study performed by the Danish government found that there are many problems in converting documents between OOXML and ODF, such as missing information and incorrect formatting.[81] These results were confirmed by another study by R. Shah and J. P. Kesan, who fund that in the best of the cases there were formatting problems, but in the worst cases, there was a loss of information that was found in pictures, footnotes, comments, tracking changes and tables.[82]

Because of all of the above and the irregularities in some of the NSBs, the ISO/IEC 29500 should not be considered as an international standard for the TBT Agreement purposes.

6 The Aftermath

After the scandal the ISO/IEC 29500 has been reviewed in 2011 and 2012.[83] This article does not focus on the technical content of the standard, but in the process through which it was adopted. In this sense it is worth noting that in 2010, the ISO and the IEC decided to modify the JTC1 Directives. Some of the changes include that during the contradiction phase it is no longer the NSBs who have to raise such contradictions (which concept is still undefined) but the Chief Executive Officer. [84] Second, if a draft standard fails to get sufficient votes, that is two-thirds of the P-Members and no more than one-quarter overall disapproval, the draft standard is dismissed and it does not go to a BRM as the OOXML did. If these rules had been in place at the time the OOXML was discussed, it would have never become an ISO/IEC standard.[85] In a way these modifications, are a recognition from both ISO and the IEC that the Fast Track Process, as it was in 2008, had severe shortcomings.

Even with these amendments, the JTC1 might not be the adequate forum to standardize rapid changing technologies. While the producer may update its software (six or more times per year) and organizations such as ECMA and OASIS make an actualization every six months, the JTC1 can only update its standard every two or three versions of the OASIS or ECMA standards. The willingness of the JTC1 to keep this pace might have detrimental effects on its legitimacy, as pointed out by SABS, there is an "increasing tendency for international organizations to use the JTC1 processes to circumvent the consensus-building process that is the cornerstone to the success and international acceptance of ISO and IEC standards".[86] In the OOXML case in particular, the Fast Track Process was not well tailored to address such a large and complex document, mostly one that has the potential of affecting "the long-term accessibility of the [world] historical record".[87] I

7 Conclusions

The standardization of the OOXML is a good example that not all standards adopted by an ISB are necessarily international standards under the TBT Agreement. In this case, the

[81] J. J. Andersen, "ODF and OOXML in Denmark", *National IT and Telecom Agency*, 2008 quoted by R. Shaha and J. P. Kesan, "Lost in Translation: Interoperability Issues for Open Standards", *Journal of Law and Policy for the Information Society*, vol. 119, 2012-2013.
[82] R. Shaha and J. P. Kesan, *Lost in Translation.*
[83] ISO web page, http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=61750
[84] ISO/IEC, *JTC1 Supplement*, 2015, F.2.2.
[85] See, R. Weir, "ISO/IEC JTC1 Revises Directives, Addresses OOXML Abuses" www.robweir.com, July 07, 2010.
[86] SABS, *Appeal from the South African national body.*
[87] A. Updegrove, *The Contradictory Nature of OOXML*

corruption accusations against Microsoft; the violations to the JTC1 procedures and the spirit of the ISO, the IEC and, the JTC1; and, the lack of compliance with the principles in the Decision, makes that the ISO/IEC 29500 cannot be considered as an international standard for the TBT Agreement. Withdrawing the characterization of international to a standard, even if adopted by a recognized ISB, relieves WTO Members from the obligation of using the standard as basis of their national technical regulations and standards.

It is important that in the forthcoming WTO cases in which a standard that is claimed to be international panels and the Appellate Body follow the path open in the *US-Tuna II* case of performing a procedural review. The possibility that the standardization process might be scrutinized may have a positive effect on ISBs and their Members, which would pay more attention to the process through which a standard is adopted and that the procedures follow the rules of the ISB, the definition in the TBT Agreement and the principles in the Decision. This would contribute to making the international standardizing system more inclusive, transparent and accountable, and in it would make be harder for single-vendors to capture the process.

Coopetition To Gain Influence, Leadership and Control n Standard Setting Organization

Karim Benmeziane — Anne Mione

MRM (Montpellier Research in Management)
benmeziane@bnae.asso.fr
anne.mione@umontpellier.fr

Abstract: *In this paper, we evaluate the benefits of coopetition strategies in a standard setting organization (SSO). We build a structural equation model using a second order construct to measure coopetition strategies. We used data from the space sector, including participation to an SSO, alliance data and a measure of rivalry. Using this model, we find evidence that a coopetition strategy is positively related to the firm's strategic position in the SSO, the strategic position being a compound of leadership, control and influence within the SSO. We also show that market coopetition isn't enough to leverage standard development and needs a set of alliances with rivals within the SSO.*

Keywords: *coopetition, standard setting, alliances, structural equation model, PLS.*

1 Introduction

The concept of coopetition builds on the idea that cooperating with competitors enables to obtain more benefits from cooperating with partners that are not rivals. Put like this, the concept does not specify the context in which it is supposed to operate. However, scholarship on coopetition mostly works on cases of coopetition on the market. The question we ask here is does this concept apply within a non- market specific institutional context?

Since the initial development of this concept when the pioneers promised that coopetition would draw superior performance than the pure competition or cooperation (Brandenburger and Nalebuff (1996); Lado, Boyd, and Hanlon (1997), and Bengtsson and Kock (1999, 2000), several empirical studies have evaluated the benefits and the drawbacks entailed by this strategy. Reviewing these contributions, Le Roy and Czaskon (2016) concluded recently on contradictory results. They observed that a contingency perspective should be respected and showed the importance of considering the context. However, as Mariani (2016) observed, a large part of the empirical studies examines coopetition within ecosystems covered with specific institutional rules without specifically measuring the impact of such rules and regulations over the success of the coopetition strategy. In this contribution, we specifically observe the relevance of coopetition in a specific institutional context. We intend to contribute on the literature on coopetition in considering its advantages in a context that enforces cooperation. Such contexts impose collaboration but do not stipulate if collaboration should apply in the same way to complementors or rivals. The partners are free to elect themselves and find allies and/or avoid rivals. In other words, an institutional context enforcing collaboration offers a situation where the collaborative advantages are important and where we should be able to find coopetition. However, collaborating with rivals entail risks and disadvantages, such potential drawbacks explaining why this strategy is not systematically adopted. In this contribution, we examine coopetition and its benefits within a standards setting process and argue that collaborating with competitors is more performant than collaborating with partners to gain influence in Standard Setting Organization (SSO)..

We choose the standard setting process for three reasons. First, standard setting has considerable consequences on the market definition of products and services and we assume that the firms are involved in such standard setting activities for strategic reasons. Collaborating with rivals on these questions can be sensitive and the arbitration between achieving collectively a standard or pushing its own standard is an important one. Second, standard setting offers a context where coopetition and its consequences can be measured. We define the strategic position as a capability of an organization to influence, lead and control a network. In other words, it is the capability of an organization to leverage the hierarchy within a group of organizations. We assume that obtaining a higher strategic position is the best way to shape the standards.

Thus, the standardization setting organization enables evaluating the impact of coopetition on something new, namely the firm's strategic position in the standard setting organization. This relationship between a coopetitive strategy and the strategic position in a standard setting organization has not been explored before. As a supplementary advantage, standard setting has long time being observed as an interesting context to observe alliances (Blind et Mangelsdorf, 2013, 2016), coalitions, but also coopetition (Yami et al., 2016). This study complements the precedent analyses. Third, the advantages of coopetition have been associated with innovation. In our mind, innovation can involve a phase of standardization. The relation between innovation and standardization has been explored by scholarship in standardization in a recent issue of Technovation (2016).

At the end, we observe three elements. At first, new markets require anticipatory standards (Egeydi and Sherif 2008) to organize commercialization. Then, one of the main objectives of firms participating into SSO is to open market (Blind et Mangelsdorf, 2016). Lastly, innovative firms are the most invested in SSOs (Mione, 1994, Leiponen, 2008, Blind et Mangesldorf, 2016). That is why we think that firms willing to enter in coopetitive relationships in order to develop innovation, will also consider coopetitive relationships in shaping standards to legitimate these innovations on the market. Our question is to evaluate the advantage of collaborating with market rivals in and out of the SSO to obtain a higher strategic position in the SSO.

Literature on standardization shows that the firms avoid competitors and rather choose complementors to make alliances within SSOs (Axelrod et al. 1995, Bar and Leiponen, 2014). We intend to investigate this question and contribute to research on both coopetition and standardization. For this, we set up a quantitative study based on data collected from the European Cooperation for Space Standardization (ECSS) over the period 1999 to 2014. This database enables observing the alliances within SSO between firms that decide to cooperate on standard projects. Then, we qualify rivalry of a firm engaged in such alliances with information on their market segmentation (Axelrod et al. 1995). We fill up this information with SDC database to collect the all the alliances of the firms involved in the SSO between 1999 and 2014, the alliances being either with SSO members or with other firms not involved in the SSO activity. This way, the ECSS data gives us information with respect to the alliances within the SSO and the SDC data gives us the information about market alliances and firms rivalry through market segmentation.

The first part of this contribution exposes the literature review on coopetition in a standardization context. The second part presents the method. The third part presents the findings and discussion.

2 Literature Review

2.1 Coopetition in the standardization process

Compared to the number of studies relating the performance of coopetition to innovation, not so many researchers have explored the performance of this strategy in a standardization process. However, some researchers have specifically raised the question of coopetition in standardization context. Recently, Yami et al. (2016) observed how Microsoft handled coopetition through different sequences in the OOXML standardization process, mixing collaboration, competition and coopetition. They exposed how the game of the leader along the standardization process is characterized by a subtle management of sequences using these three relational modes in order to achieve its goals. Blind et Mangesdorf (2016) mentioned coopetition in exploring motives of firms in participating to SDOs. Exploring the motives to participate in AFNOR, Mione (2009) showed how coopetition into SDO was required to settle the conditions to develop a new market. Gnyawali and Park (2011) described coopetition in the standard battle between blue Ray and HD-DVD standards. Oshri & Weeber (2006) pointed out that both relational modes (competition and cooperation) can coexist at different stages of the development of a de facto or de jure standard. They showed that actors have the choice between pure relational modes –cooperation or competition–, or different levels of hybrid mode, at each stage of the development of a standard. This approach had already been developed in numerous works (Axelrod et al., 1995; De Laat, 1999) and underlines the interest to deepen our knowledge of relational modes (cooperation and competition as "Pure Modes" and coopetition as a "Hybrid Mode") when a new standard emerges. From a neoinstitutional perspective, Lindgren et Holderson (2012) showed the shaping of environmental standard in the sector of transport described as coopetitive. Garud et al. (2002) studied the establishment of a technology standard proposed by its designer – the standardization of Java sponsored by Sun Microsystems – showing that this standardization effort involved “coopetition”.

These researches explicitly mentioned coopetition. However, scholarship on standardization have traditionally considered alliance perspective in the standardization process.

2.2 Alliances to favour the standardization process

We consider the literature on alliance and coalitions in standardization research. From the seminal work by Shapiro and Varian (1999), it is admitted that firms should rather find allies than going alone when trying to develop a standard. As far as formal standardization is concerned, participating into SSO is admitted as a form of alliance. Blind and Mangelsdorf (2013) argued that committee based coordination in standard setting, aimed at discussing and producing technical specifications, is one specific form of alliance. According to the authors, the following three characteristics are conditions for inter-firm collaborations to be considered as strategic alliances: (1) the partners remain independent after the formation; (2) they share benefits and control over the performance of assigned tasks; and (3) they continuously contribute to the mutually-defined strategic areas (Yoshino and Rangone, 1995). Standardization alliances are considered as strategic alliances, because they satisfy these three conditions (Blind and Mangelsdorf, 2013). Finally, standardization – defined by De Vries et al. (2003) as the development or revision of a standard or a cluster of related standards – involves a continuous contribution by participants, by involving the right expertise. We agree with this view but suggest discriminating within alliances between rivals from alliances between non-rivals in the standard setting organization.

Some authors have supported the idea that alliances in SSO relate to alliances in the market. Warner (2003) established that block alliances in standard setting are emerging from market-driven to formal or committee-based processes in the case of information and communication industry. In that case, the relationship between SSO alliances and market driven alliances is described as univocal. Other findings on the links between SSOs and strategic alliances include that inter-firm relationships are enhanced by long-term individual bonds developed within a technical committee (Rosenkopf et al., 2001) Rosenkopf et al.'s work is particularly interesting as it is focused on the effect of technical committee coordination towards alliance formation instead of the reciprocal. Their study explained how technical long-term relationships between experts can foster knowledge exchange at firm level, diminishing market uncertainty and therefore enhancing the likelihood for firms to form a strategic alliance. Following the reverse perspective, Benmeziane and Mione (2015) showed how participating into SSO could open opportunities to settle alliances in the market. However, except from Benmeziane and Mione (2015), these analyses did not take into account the effect of rivalry between partners on the relationship between SSO alliances and alliances on the market.

2.3 Coopetition and its impact on alliances and strategic position SSO

Literature on standardization research considers that participating into SSOs is a strategic alliance (Blind et Mangelsdorf, 2016) without differentiating the nature of the relationship between the involved partners, especially their level of rivalry. Only Axelrod et al (1995) identified allying with rivals as a negative effect. Axelrod et al. (1995) define the incentives to join standard-setting alliances: first, the alliance should be as wide as possible because probability that a technology becomes a standard increases with the size of the alliance offering a compatible product. Second, the size of the alliance will often conflict with competitive considerations during the process of setting standards. Although being allied with a rival might increase the size of the alliance (and the adoption likelihood of the standard proposed by the alliance), rivals will be able to engage in effective price or product competition in post-adoption for the standardized product or service. When this happens, standardization provides little to no benefits to the firm that competes in the same market. Therefore, firms would rather join an alliance where rivals are less present as possible. In Weiss and Sirbu (1990, p. 112), “firms must prevent their competitors from gaining an advantage at their expense”. According to Axelrod et al (1995), the intensity of rivalry between two firms increases with the extent to which the firms (1) offer functionally equivalent but incompatible technology and (2) have similar market segmentation profile. The intensity of rivalry will be particularly high among firms that a similar segmentation. Thus literature supports that the first movement to create an alliance within SSO is to gather complementors instead of rivals. We question this statement.

Indeed, despite of these finding of the literature, we follow coopetition literature and we expect a superior performance of this strategy than only competition or cooperation. In our case, performance is the strategic position in the SSO, strategic position being a construct which contains the leadership, the control and the firm’s influence in a standard setting organization. We expect that firms will promote their innovation through relationships with partners and competitors when the creation of a new market is concerned. We also believe that dynamic innovative firms willing to shape standards will accept relational modes that are necessary in a formal context of constrained collaboration. For these reasons, we form three hypotheses.

3 Hypotheses

First, we consider the impact of alliances on the opportunity of obtaining a higher strategic position, both being considered within a standard setting organization. We dig on the idea that cooperating with partners allows a firm to be identified as an important contributor and to gain legitimacy. Leiponen (2008) showed that the position in an alliance network fosters firm's ability to success in standard setting. The first hypothesis is:

H1: Forming alliances in a SSO has a positive effect on a firm's Strategic Position in this SSO

At firm-level, with the exception of Rosenkopf et al. (2001), most studies explored the effect of alliance formation on standard setting coordination. This is explained by the fact that industrial standard's literature is treating the "emergence of a standard as problematic" (Funk, 2003). Market product adoption is considered happening before standardization, especially in the case of de facto standards. Indirectly, this posture has oriented most of past researches to the exploration of how market relationships are transferred into committee-based coordination systems such as standard setting organization. In this contribution, we dig up this perspective and explore the nature of the relationships between the allies. When the rivalry is high, We think that alliances partners are likely to develop similar alliances within the SSO,. In a sense, alliances will carry existing rivalry from the market into the SSO. For this reason, coopetitive partners are more likely to work in similar working groups in order to gain benefits from the alliances developed on the market. We thus draw the hypothesis:

H2: Forming Coopetitive relationships in the market has a positive effect on the formation of alliances in the SSO.

Finally, we consider rivalry within the SSO by considering the rivalry level of alliances partners involved in SSO Alliances (all SSO members are involved in different alliances in the market). We argue that coopetitive partners within the SSO are more likely to get higher strategic position which enables them to lead, control and leverage the standard setting. Indeed, we believe that a firm able to obtain the support of its rivals will be legitimate to endorse higher hierarchical position within the SSO. The coopetitive skills appear here as political "adroitness" in the institutional context. It may also underline the capacity to find "win-win" relationships in a technological field. For these reasons, we establish the following hypothesis:

H3: Forming Coopetitive relationships in the SSO has a positive effect on the firm's Strategic Position in the SSO.

4 Research Methodology

4.1 Context of the study

We tested our model using two sources of data. The first one is alliance data over the period 1999 to 2014 from the European space sector industry using SDC database. The European space sector witnessed substantial changes in that period from the development of the Ariane 5 launch vehicle to the development of new kind of telecommunication platform and payload such as Alphabus and Alphasat. These new programs have led to several alliances maneuvering. The second source of data comes from a standard setting organization, the European Cooperation for Space Standardization (ECSS) over the same period (1999-2014). The ECSS is a standard developing organization regrouping National Space Agencies (CNES in France, DLR in Germany, ASI in Italy, the UK Space Agency etc.), the European Space Agency, and industrial stakeholders gathered under the umbrella of Eurospace which is the trade association for European space companies. Participation is open to any space company or any organization which has an interest in the technical work done within ECSS. Thus, we collected all the participations from participating entities (150 organizations) in each of the structures the ECSS contains (over 180 structures, from technical working groups to governance structures). We consider the participating organizations as a sample of the overall number of organizations involved in European space activities (over 600). Although the ECSS was created in 1994, we began our collection of data when the ECSS batch of standard was first applied, that is in 1999 for the Mars Express mission, the spacecraft being launched in 2003. Also, we choose ECSS because it is a typical de facto standards producing organization.

4.2 Operationalization

4.2.1 The coopetition second order construct

The main challenge when studying coopetition related issues is the measure of the concept (Dagnino et al. 2007). This challenge consists in aggregating two paradoxical constructs, cooperation and competition, in one upper-level construct. It also consists in building measures of cooperation and competition which become somehow compatible when combined in a second order construct. In other words, even if quality of first order measures for competition and cooperation are acceptable, these measures have to be combined "formatively" so that the coopetition construct variability is well explained by the two lower level constructs.

Our second order construct is an "aggregation" of the two following first order constructs: the "EQ Alliances" construct which is a measure of a firm's cooperative ties on different markets (as a result of forming strategic alliances) and "Rivalry" which measures a distance with rivals on those markets (in short, we consider two firms as close rivals if they share the same market segmentation with the same firms). This aggregation of first order constructs into a second order construct comes from a peculiar view of the coopetition concept. Whereas coopetition is defined in the literature as simultaneous competition and cooperation which entails a vision of pure coopetitive interactions, we argue that coopetition is somehow a scalable concept. This means that we admit the possibility of a low level coopetition and a high level coopetition. The low level coopetition is a situation where competition and cooperation are low. Likewise, the high level coopetition is a situation where competition and cooperation are high. From this perspective, cooperation and competition are special cases of coopetition. Cooperation is coopetition with low competition and competition is coopetition with low cooperation. This is different from what the literature considered when the coopetition concept was introduced. For instance, Lado et al. (1997) considered coopetition as a syncretic behavior while the firm is seeking for situational rents. In their views, coopetition happens when the competitive and cooperative orientations of a firm are "strong" which means coopetition is a manifestation of the firm's behavior. It also means one may observe coopetition through the lens of firm's interactions. We argue that we may observe coopetition not only through interactions but also through the relative position of a firm towards other firms and the way they decide to coordinate their actions. In a way, strategic alliance is a peaceful way of coordination. Even if two firms create a joint venture to sell products, the two firms do not directly use the market as a coordination means (Coase, 1937), they build ties in order to create the joint venture that will interact with the market. Likewise, when two firms are defined as competitors, it is a signal that they use the same coordination mechanism to make transactions. This network based view (Powell, 1990) allowed us to build a measure of rivalry which is compatible with a more classical measure of alliances. The measure of rivalry is based on the fact that several firms are using the same coordination mechanisms (e.g. firms are sharing the same market segmentation). We used a metric somehow similar to assortativity in social network theory to evaluate the proximity. On the other end, the measure of alliances is based on network metrics in cooperative networks such are degree and Eigen value centrality. Being combined, those two first order constructs formatively measure coopetition as a second order construct of coopetition.

Back to our research model, we also built two first order constructs. The Strategic Position within the SSO and the level of Alliances within the SSO. We specifically aim at explaining how firms would gain a higher strategic position within the SSO either in association with the SSO as a cooperative network or in association with the development of a coopetitive network.

4.2.2 Rivalry

We operationalize rivalry as a concept close to multi-point competition. The reason is that the space sector is a niche market. Firms involved in space activities are often involved in other markets using the same array of technologies or products. Moreover, some segments of the space sector use converging technologies. This is particularly known when the space technologies converge with Business to Consumers applications (e.g. satellite telecommunications or positioning and navigation information used by mobile phones) but this remain true when considering Business to Business markets. For instance, cryogenic solutions are used for industrial cleaning or medical applications while being developed and used to propel a space rocket into Earth orbit. This means that rivalry may occur at the same time on different markets, space related activities being one of them.

In the industry organization literature, rivalry is usually measured in terms of actions and counter-actions taken by competitors or potential competitors (Porter, 1980). In this paper, we prefer the definition of rivalry used by Axelrod et al. (1995) who define a dichotomist measure of rivalry: firms can be either close or distant rivals. As mentioned by the authors, this dichotomy is similar to the notion of strategic group segmentation (Cave and Porter, 1997). A close rival (which amounts to intense rivalry) is considered as belonging to the same strategic group. However, in a context of multi-point competition, strategic groups did not seem an appropriate segmentation since firms could belong simultaneously to several strategic groups. Closeness of rivalry had to be refined in order to take into account multipoint competition and latent competition. Therefore, we build a 7-level Likert scale in order to evaluate the intensity of rivalry using the Standard Industrial Classification (SIC) Code in order to determine the firms' activities while they were forming an equity arrangement alliance. The scale value is coded as 1 if there is no rivalry, meaning that two firms do not have any similar SIC Code and 7 when they share one or several 4 digit SIC Code. Intermediate levels describe firms sharing one or several major industry groups (2 digits in common), or one or several industry groups (3 digits in common). Final segmentation shows for instance that Airbus and Thales are intense rivals in manufacturing activities whereas firms such as SSI, Xilinx or Logica are intense rival of Airbus and Thales in services activities, Airbus and Thales being distant rival in this area of activity. Thus, we built a 90x90 order symmetric matrix (90 being the number of firms in our sample which also include other types of organizations such as National Agency, Centers of research…), and took the marginal mean for each row of the matrix. This marginal mean constitutes a measure of rivalry intensity for each firm. Then we counted the number of non-zero values in the initial matrix in order to identify the number of different rivals for each firm. This data process allowed us to obtain the rivalry diversity.

4.2.3 Strategic Position within the SSO

To operationalize this construct, we used two variables, the first one being the influence of a firm in the SSO (SSO_INFLUENCE) and the resources used by a firm in the SSO (SSO_RESOURCES). We defined the influence with two items, the first one being the authority a firm has in the SSO, the other one as the level of control a firm has. The authority is measured by the hierarchical position in terms of voting rights per structure. In the specific case of ECSS, voting rights are held directly by participating organizations. More precisely, ECSS members are National Space Agencies and the space industry. The number of voting rights is equally split between those two categories on the basis of one organization/one vote. It is somehow different from the case of *de jure* standards developed by official organizations such as CEN or ISO where the delegation principle makes it difficult to evaluate the individual authority a firm have on the SSO activity since National Standardization Bodies gather stakeholders' opinion in order to vote at European or international level.

Thus, for a specific firm, the authority measures the number of structures the firm has a voting right in. We also scaled the different structure in order to give a higher weight to governing structure than to actual standards developing working groups. This approach may be arguable but we considered that, in many SSOs, the launch of New Work Items as well as decisions formalizing consensus are taken in higher level structures than working groups. This is also the case for de-jure standards. For instance, CEN regulation stipulates that the Technical Committee in charge of a project shall produce a formal decision for a project to be circulated for an Enquiry. Moreover, this decision is delegated by the Technical Board whose members can ultimately disclaim the decision taken by the Technical Committee. This kind of escalation in the decision making process is quite common in SSOs, therefore enforcing our approach. Also,we defined the level of control simply as the number of working groups convened by a specific firm. We measured the resources as the number of experts involved in working groups.

4.2.4 Alliances in the SSO

The concept of strategic alliance can be very wide. From contractual arrangements between firms pooling their resources in order to produce a product, sharing R&D investment risks or mutualizing marketing or logistics activities and costs to equity arrangements possibly involving the creation of a new entity (e.g. a Joint Venture), a strategic alliance can take diverse forms. Examples of works dedicated to specific forms of alliances count R&D alliances (Pisano, 1990; Schoenmakers and Duysters, 2006; Röller, Siebert, and Tombak, 2007), the link between the firm's innovation capabilities and its patent portfolio (Mowery et al. 1996; Cowan and Jonard, 2009), joint production alliances (Saxenian, 1991; Audretsch and Feldman, 1996) to cite a few. In this paper, we focus on strategic alliances of a peculiar form, namely Standard Setting alliances and Equity Arrangements alliances (Yoshino and Rangone, 1995). Yoshino and Rangone differentiate strategic alliances according to inter-firm linkages, dividing them into two categories, contractual arrangements and equity arrangements, and describing only some of them as strategic alliances: on the first part, buy/sell contracts, franchising, cross-licensing are seen as traditional contracts but not as strategic alliances. Joint R&D, joint production and development, joint manufacturing or marketing, standards setting are seen as non-traditional contracts and as strategic alliances. On the second part, equity arrangements depend on the creation of a new entity and the subsidiarity to multinational corporations (MNC): 50-50 as well as unequal equity joint ventures (JV) are the only equity arrangements (EQ) considered by the authors as strategic alliances (as opposed to JV which are subsidiaries of MNCs and to Mergers and Acquisitions which are not strategic alliances). Thus, our study focuses on the effect of inter-firm linkages in standard setting alliances (as a non-traditional contractual agreement) on the inter-firm linkages in equity arrangements alliances, involving or not the creation of a new entity as long as this potential new entity is not a subsidiary of a MNC.

Blind and Mangelsdorf (2013) argued that committee based coordination in standard setting, aimed at discussing and producing technical specifications, is one specific form of alliance. In order to build a measure of such alliances, we used metrics from the social network theory: the degree (e.g. the number of ties the firm), the Eigen-vector centrality (e.g. the place of the firm in the cooperative network) and the number of different nodes a firm may have (e.g. the number of distinct partners).

4.3 Model building and testing

To build our model we used a variance based structural model, namely Partial Least Square Structural Equation Model (PLS-SEM). We chose this kind of method because PLS-SEM is known to handle small sample size (n=90 can be considered as a small sample size). It is used when applications have little available theory (the relationships between the institutional context and coopetitive strategies are not deeply studied and we lack of a theoretical framework). Lastly, PLS-SEM, as a non-parametric methodology, handles skewed data distribution (Bacon, 1999; Hwang et al. 2010; Wong, 2013).

To integrate a second order construct based on formative first order constructs, we followed a two-stage approach. *"The two stage approach is when latent variable scores are initially estimated without the second-order construct present, but with all the first order constructs only within the model (Agarwal and Karahanna, 2000, Henseler et al., 2007). The latent variable scores are subsequently used as indicator in a separate higher-order order structural model analysis. Thus, a two stage approach".* Even if the literature indicates that other methods exists in order to create a higher order structural model (such as the hierarchical method or the hybrid method), the two-stage approach *"may offer advantages when estimating higher-order models with formative indicants"* (Diamantopoulos and Winklhofer, 2001; Reinartz, Krafft, and Hoyer, 2004) which is our case here, market alliances and rivalry being formatively associated with the coopetition second order construct.

4.3.1 Validation of the measurement model (outer model)

This portion provides an evaluation on how accurate (i.e. reliable) the measures are and also their convergent and discriminant validities. The following tables report, for the first stage outer model, the Average Variance Extracted which is an indicator of convergent validity when greater than 0.5 (Figure 1) along with outer-loadings greater than 0.7 (table 1). At this point we assume that the EQ Rivalry mean level outer-loadings is close enough to 0.7 (0.694). The reliability of the measure is reported through the composite reliability (figure 2).

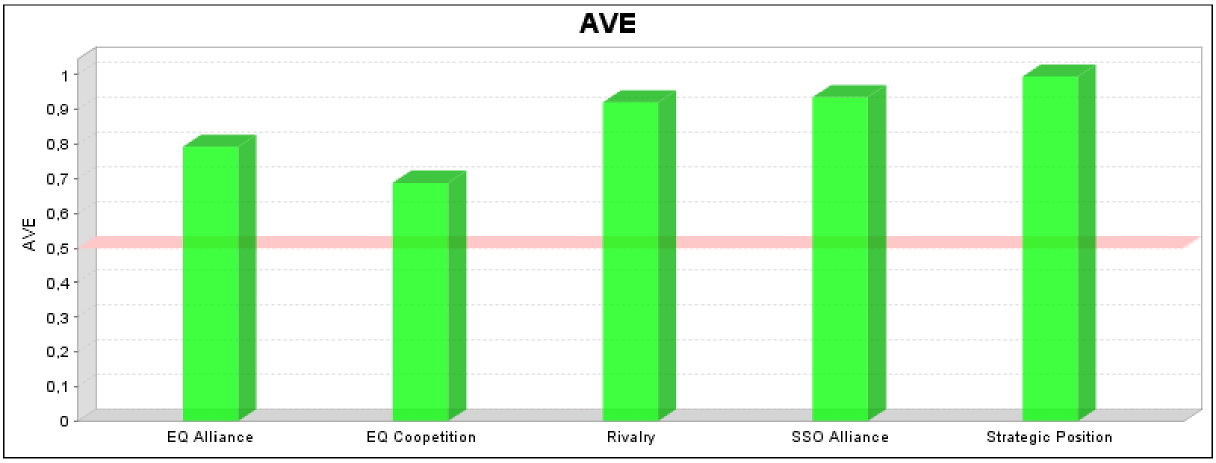

Figure 1. Average Variance Extracted

Table 1. Outer loadings

	EQ Alliance	EQ Coopetition	Rivalry	SSO Alliance	Strategic Position
EQ_Rivalry_meanlevel			0.95		
EQ_Rivalty_diversity			0.969		
EQ_Rivalry_meanlevel		0.694			
EQ_Rivalty_diversity		0.88			
EQ_alliances_NSSO		0.848			
EQ_alliances_SSO		0.857			
EQ_partners		0.856			
EQ_alliances_SSO	0.924				
EQ_alliances_NSSO	0.885				
EQ_partners	0.861				
SSO_control					0.995
SSO_influence					0.999
SSO_ressources					0.998
SSO_EigenCen				0.937	
SSO_partners_diversirty				0.988	
SSO_partners_level				0.978	

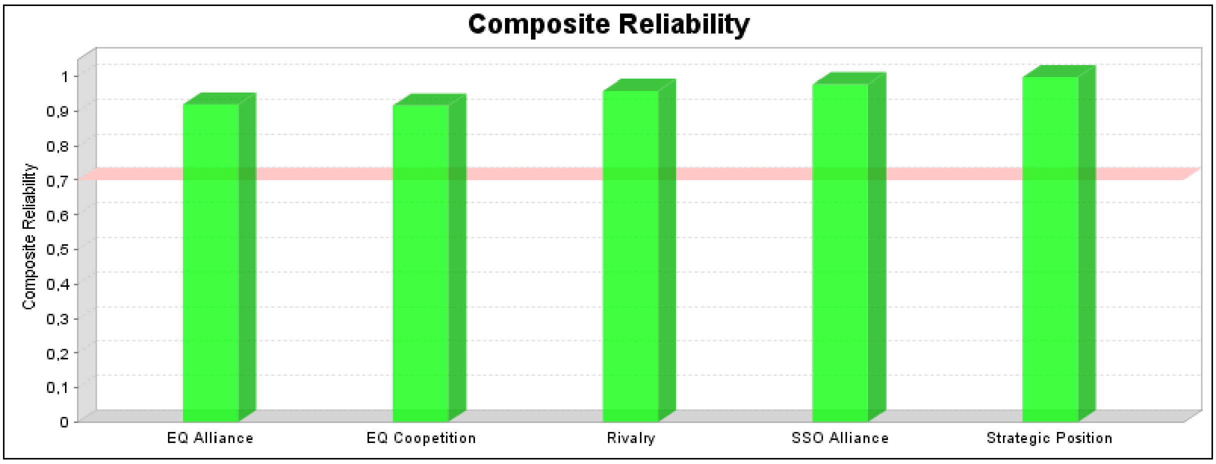

Figure 2. Composite reliability

4.3.2 Validation of the structural model (inner model)

The structural model consists of the relationships between the constructs. PLS structural equation modeling relies on non-parametric bootstrap procedure to test coefficients for their significance (Davison and Hinkley, 1997; Efron and Tibshirani, 1986). The result of a 5000 bootstrap samples is exhibited in table 2.

*Table 2. bootstrap procedure results (**p<0.05; ***p<0.01)*

	Original Sample (O)	Sample Mean (M)	Standard Error (STERR)	T Statistics (|O/STERR|)	P Values
EQ_Coopetition -> SSO_Alliance	0.684	0.591	0.253	2.707	0.007***
EQ_Coopetition ->	0.145	0.118	0.093	1.563	0.118

SSO_Strategic Position					
SSO_Alliance -> SSO_Strategic Position	0.836	0.799	0.118	7.063	0***

The coefficients of the structural model are exhibited in figure 3. The inner model shows highly significant effect of SSO Alliance on SSO Strategic Position (p<0.01) and highly significant effect of EQ_Coopetition on SSO Alliance (p<0.01). Thus, we validate H1 and H2.

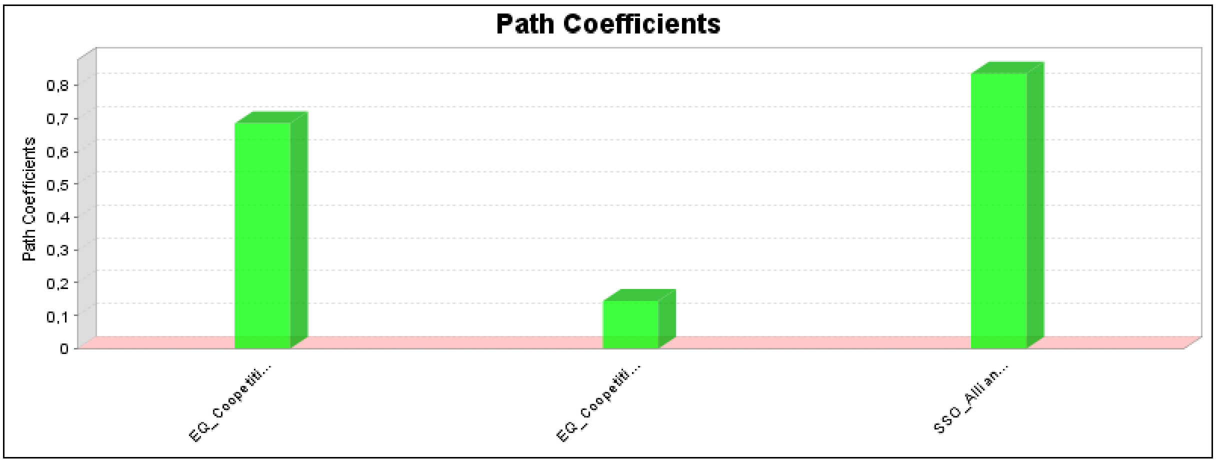

Figure 3. Structural model coefficients

To test for H3, we split our data according to rivalry level and we run the inner model only with firms with a high level rivalry. The path coefficients are reported respectively in figure 3 (both low and high rivalry) and figure 4 (high rivalry).

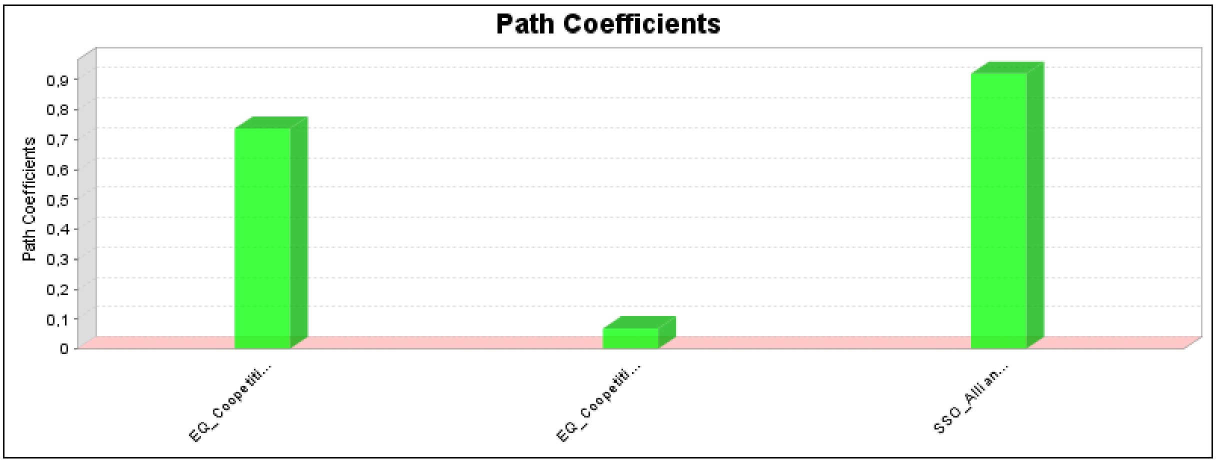

Figure 4. Structural model coefficients – Firms with high level rivalry

We find a highly significant effect of SSO Alliances for firms with a high level rivalry (0.737 with a p-value<0.01) which allows us to validate H3. Table 3 summarizes our results.

Table 3. Summary of results

H1: SSO Alliances has a positive effect on SSO Strategic Position	**Accepted ($p<0.01$)**
H2: EQ Coopetition has a positive effect on SSO Alliances	**Accepted ($p<0.01$)**
H3: SSO Coopetition has a positive effect on SSO Strategic Position	**Accepted ($p<0.01$)**

5 Findings

In this contribution, we had three objectives. First, we showed evidence of the effect of SSO Alliances on the firm strategic position in the SSO (H1). Second, we analyzed the effect of market related coopetitive relationships on SSO Alliances (H2). Finally, we explored the relationship between market alliances and SSO strategic position (H3).

5.1 Effect of SSO Alliances on SSO Strategic position (H1)

Validation of Hypotheses H1 indicates that standard setting alliances have a significant effect on how the negotiation process to establish a standard is handled by the participants (Hargrave and Van de Ven, 2006). The leadership, the control and the influence are the most valuable characteristics for a firm to get the upper hand in a standard setting alliance because it allows it to actually rule on the development of the standards as well as the organization of the SSO. We showed that this higher strategic position is more likely to be obtained when associated with a high level involvement in alliances within the SSO.

5.2 Effect of EQ Coopetition on SSO alliances (H2)

Validation of hypothesis H2 underlines that coopetition on the market has a positive effect on alliances within a SSO. From this relationship we learn that our market alliances construct is positively associated with alliances in the SSO even in the case where firms are market rivals. We may think that this is somehow in contradiction with the literature, which usually states that developing standards is a matter of coordination and that rivalry, or more narrowly market competition, hampers this development. This is partially explained by the fact that the literature focused on the effect of rivalry on the emergence of standards, while our model is focused on the process of developing standards, which entails the fact that even rival firms agree to participate in the same technical committee and working groups in a given SSO. In the end, our results do not contradict the literature which is more focused on the output of the standardization process (aka the standard itself) than process itself. In other words, rivalry can hinder the production of standards but we show that it does not exclude rivals to forming alliances while participating in a working group..

5.3 Effect of SSO Coopetition on SSO Strategic position (H3)

Coopetition within the SSO has a positive effect on the strategic position of a firm within the SSO. This relationship shows that coopetitive ties within the SSO is positively associated with strategic position. When adopting such a coopetition strategy, a firm can leverage a broader set of technical works, and participates to the organization of the SSO at different hierarchical levels, mainly because the presence of their coopetitors does not prevent them to be involved in the decision making process of the SSO. Conversely, firms with a low level of SSO coopetition (which means alliances with non-rivals) leads to lower strategic position. This is because the firm prevents itself to participate to different kind of activities (either technical or management related) because of the presence of their rivals.

6 Discussion

We have measured three effects of collaborative relationships in a Standard Setting Organization. We first have checked the importance of allying to obtain strategic position in SSO. Then we showed that coopetitive alliances have a positive impact on alliances in SSO. And finally, we found evidence that a higher level of SSO coopetitive relationships allows for a higher strategic position in the SSO. Thus, we conclude that coopetition is a relevant strategy for firms pursuing the following two objectives which rely on coopetitive strategies: finding allies is more likely to happen and higher strategic position are more likely to be accessible. These two findings seem consistent.

In order to give robustness to our findings we also have measured the direct impact of market coopetition on strategic position in the SSO. The fact that we couldn't find evidence of such an effect adds confirmation to our idea that to gain strategic influence in SSO, firms have to ally within the SSO, even with rivals. Alliances on the market are not sufficient to be in a position to shape formal standard. This result advocates for the firm's involvement in formal standardization and confirms literature considering the importance of allying in formal context. Nevertheless, our findings go beyond this traditional view: SSOs alliances should involve rivals. To understand the central role of coopetitive relationships in SSOs, we keep in mind that the main mission of a standard setting organization is to help private interests to "*craft effective consensus*" (Simcoe, 2012). In other words, when diversity of private interest hampers an efficient technological choice, SSO helps coordination between those private interests in order to help choosing between technologies and increase its likelihood in becoming a viable market standard, even at the cost of being cooperating with rivals.

The adoption of the coopetition model leads to a peculiar orientation. This contribution aims at refining the definition of the coopetition concept (Bengtsson and Kock, 2014) by contributing to the debate between two perspectives on coopetition, the emergent and deliberate nature of such a relationship Choosing a specific institutional context, we deliberately placed our observation into a context where coopetition is constrained (Mariani, 2009). However, we showed the leeway enabling the firm to opt for different relational mode. In our mind, this cannot be a random effect. We consider that the firms engaged into coopetition on the market acquire specific skills which enable them to manage coopetition into an institutional context. This means that the more operant strategy is not only to settle alliances on the market and invest together SSOs to push your standard. Firms cooperating with competitors in the market have acquired some relational capacity to be able to seize the opportunity to collaborate with rivals while preserving from opportunism from its rivals.

The external validity of our findings may be discussed. First, we choose the space sector which can be considered as a very institutionalized activity, meaning it is governed by policies and operated through many rules among which are technical standards. Nevertheless, the global the privatization trend in the space sector, which has begun a few decades ago with the telecommunication operators, is pursuing with an increasing competition in the satellite manufacturing market segment, the development of services based on satellite data, new forms of partnerships between public and private entities in the space launcher segment (manufacturing and launch services), especially in the U.S. (e.g. Space X), and in Europe (Airbus Safran Launchers, ELV), and the growing importance of newcomers such as Google or Facebook buying hundreds of satellites for billions of dollars. This means that although policies and institutions remain important (for national defense and sovereignty related issues), the space sector is increasingly driven by fragmented market interests for which technical standards remain the globally the same (or more precisely remain driven by the evolution of technology). This is supported by our data.The average intensity of rivalry is 2.23 and average rivalry diversity in 1.29. This means that globally the rivalry is quite low which seems consistent considering the space sector in Europe as quite regulated for infrastructure manufacturing - space launchers, satellites and ground stations – (which means a few numbers of intense rivals and specialized for downstream activities - satellite maintenance, wholesale of satellite capacities, application services – (which means a high number of low level rivalry.

Another limitation for external validity may be the fact that our model did not take into account social capital effects. We certainly admit that the social capital of experts plays an important part in their ability to draw alliances especially with competitors. A precedent experience led with competitors within SSO may enable the experts to work together in spite of the rivalry between the firms they belong to. In other words, we encourage further researches to integrate in their models effects at individual level such as the expert's experience and legitimacy in their domain of expertise. We also encourage to include longitudinal data which can integrate for instance the effect of prior alliances as one major driver of alliance formation in the literature. Our objective was to analyze the formation of alliances considering two things: the link between non-market and market alliance formation and the level of rivalry in those alliances. Doing so, we limited our measures at the organizational and inter-organizational levels, excluding the effects, at individual level, of social capital on the alliance formation likeliness.

7 Conclusion

In this contribution, we have considered the relevance of coopetition to gain a strategic position and leverage the development of standards. Our idea was that while being in an institutional context enforcing cooperation, firm's coopetition strategy can emerge naturally and demonstrate its benefices. However, literature on standardization showed that firms preferably chose complementors to ally and support standards (Axelrod et al 1995, Leiponen, 2008). To contribute to this debate, we realized a quantitative analysis based on the data from both the market and the institutional context. We could identify the alliances within the technical committees and relate these alliances to the hierarchical position of the firms in the SSO. Then, we qualified the status of the allies according to their rivalry level on the market. This way, we were able to evaluate different effects of coopetition on the strategic position of the firm within the SSO, the strategic position being the way a firm is able to lead, control and influence the standard development. These effects have two benefits: finding allies within the SSOs, even if those allies are rivals, and the capacity to gain higher strategic position within the SSO. Finally, a social capital approach would enable to further explore these insights.

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The Influence of Patents and Standards as Knowledge Sources on Innovation

Knut Blind[a,b,c] *and Jakob Pohlisch*[a]

[a] Technische Universität Berlin, Chair of Innovation Economics, Marchstraße 23, 10587 Berlin, Germany

[b] Rotterdam School of Management, Erasmus University,

[c] Fraunhofer Institute of Open Communication Systems FOKUS,

Abstract: *This paper investigates the impact of using patents and standards as information sources on the innovation performance of firms. While there is sound empirical evidence on the significance of using external sources of knowledge for generating successful innovations, little is known about the relevance of patents, and particularly standards as codified external knowledge sources. Furthermore, it is an open question what role absorptive capacity, i.e. in-house R&D, but also active patenting and standardization can play for the effectiveness of using these two knowledge sources. Based on data from the German CIS, we find that both knowledge from patents and standards are important drivers for innovation performance. However, companies without in-house R&D benefit more from those sources compared to firms with in-house R&D. Further, they seem to be able to capitalize more on standards than on patents. By combining the above results with information on the degree of novelty of innovations, we find that standards are more important for incremental innovations, while patents are more important to radical innovations. Consequently, our findings have important implications, both for companies' innovation management and for innovation policy.*

1 Introduction

External knowledge sources play an increasing role for companies' innovation strategies and success. This insight is one element of Chesbrough's paradigm of open innovation (Chesbrough, 2003). Following the seminal contribution by Laursen and Salter (2006) and related empirical studies (e.g. Tseng et al. 2011), it has been empirically shown that the use of external sources of knowledge is positively influencing companies' innovation success. However, they already found an inverse U-shape between the number of sources used and innovation success, i.e. there is an optimal number of sources beyond which the use of additional sources may have a negative impact on companies' innovation success. They argue that firms may "over-search", driven by past experiences and future expectations of managers, with negative consequences for their innovation performance. They rely on Kogut's (1997) line of arguments based on limited absorptive capacity (Cohen and Levinthal, 1990) in general, a congestion of ideas in specific circumstances and limited attention (Simon, 1947; Ocasio, 1997) generating an implementation problem. However, Laursen and Salter (2006) counted the number of sources and did not analyze the impact of individual knowledge sources. Whereas Grossmann et al. (2015) look at the interrelation between suppliers, customers and competitors as external knowledge sources and companies' involvement in standardization, we focus on patents on the one hand and standards on the other hand as external knowledge sources. They are both codified knowledge, which is available either for free, like in case of patents, or for a limited fee, like for some standards. In addition, they represent outputs of applied research and even development, whereas most scientific publications are outlets of basic research. However, patents are applied by single or small groups of inventors or companies aiming to protect their intellectual property right or trying to achieve other strategic motives (Blind et al., 2006). In general, using patent protected knowledge in own products or processes requires the payment of licensing fees or providing access to own patents via cross licensing (Köhler, 2011). In contrast, standards are the results of a more or less open and consensus-oriented standardization process driven by various motivations including enforcing own interests (Blind and Mangelsdorf, 2016). Consequently, we can expect heterogeneous impacts on companies' innovation activities and success, because patent applications, not necessarily granted patents, represent leading edge technologies, whereas standards are eventually a common denominator of the negotiation process of the interested stakeholders.

Besides the specific interrelation between patents and standards as knowledge sources for companies' innovation activities, we include in our considerations the question whether companies actively use patents as appropriation strategy (James et al., 2013) and are involved in the standardization processes. More specifically, we are interested on the one hand in the question if using patents as a knowledge source is interrelated with companies' patenting strategies, i.e. is using a private right positively connected to trying achieve such a right and what are the implications for companies' innovation performance. On the other hand, relying on a public (Kindleberger, 1983) or a at least a club good and contributing to the production of such a source of knowledge is another combination of companies' strategies and might have a slightly different impact on innovation. Overall, we have a typology of four different strategies in addition to the baseline on neither using one of the two knowledge sources nor applying for patents or getting involved in standardization. The patent focused company applies patents and uses patents as a knowledge source. In general, this is a protective approach required to disclose the own knowledge, combined with relying on knowledge produced by others. The standards focused company uses the knowledge commonly generated by others' and own efforts. A strategy very focused on the own interests is the combination of patenting with or without using patents as knowledge sources and relying on standards as publicly available public, or at least club good. Just contributing to standards without protecting the own know how via patenting is in line with the partial revelation of knowledge (Alexy et al., 2013) as a strategy to reshape the collaborative behavior of other companies. Eventually, we try to answer the question which impacts these strategies have on companies' innovation activities and success.

The hypothesis claiming that higher expenditures in R&D increase the knowledge stock and ability to adopt knowledge from external sources, i.e. the firms' absorptive capacity (Cohen and Levinthal, 1990) seems to be widely accepted. Nevertheless, there is some evidence for a substitution effect of internal R&D and the amount and success of external searching (West and Bogers, 2014). In this paper we are going to analyze the impact of own R&D expenditures on the ability of firms to capitalize on knowledge from patents and standards.

Knowledge codified in patents and standards differs in its degree of novelty, with patents containing information on much more leading-edge technologies than standards, which represents in general a consensus both between different technology providers and various technology implementors. Thus, it seems natural to ask whether the novelty of the source of information is related to the innovation performance of the firm with respect radical vs. incremental innovations.

The remainder of the paper is structured as follows. In a first step, we review the existing literature on knowledge sources in general and the limited work focusing on patents and standards in particular. Furthermore, we focus on patenting and standardization as appropriation strategies within the conceptual approach of James et al. (2013). Based on the literature review, we derive four basic hypotheses. In the fourth chapter, we present the data of the German Innovation panel, the Community Innovation Survey, collected in 2012, combined with data of companies participating in the German Institute for Standardization DIN. We will further introduce the variables and econometric model used in our approach. The fifth chapter displays the results of various regression analyses followed by their discussion. In the conclusion, we present the managerial implications of our results, but also the limitations of our research.

2 Theoretical Background

The firm profiting from an innovation is not necessarily the one with the capabilities to create them (Chesbrough, 2006). Although internal R&D is a very important determinant for the innovation performance of firms (e.g. Mairisse and Mohnen, 2001), it is potentially only one factor for search efforts undertaken by a firm (Patel and Pavitt, 1995). Thus, patents, standards as well as the patenting and standard-setting process constitute external sources of knowledge, which a firm may use to complement their own idea-generating process and thereby increase their innovative performance. Open innovation can be defined as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries" (Chesbrough & Bogers, 2014: 17). The concept provides firms with a framework on how to manage inflows and outflows of knowledge in a way that is beneficial to their innovation performance (Chesbrough, 2003). In other words, "open innovation is a powerful framework encompassing the generation, capture, and employment of intellectual property at the firm level" (West and Gallagher, 2006: 319). Following Bogers and West (2012), firms may source not only knowledge but actual innovations, technical inventions, market knowledge and components to increase their innovation capabilities. Along these lines, using information from patents and standards can be seen as a part of the open innovation paradigm introduced by Chesbrough (2003).

Open innovation is often compared to the 'proprietary' model, meaning that own R&D efforts lead to new innovative products (Chandler, 1990). West and Gallagher (2006) therefore state that this internal effort to create innovations is systematically complemented by searching a wide range of external sources to subsequently combine the sources and maximize the resulting returns. This line of thought shows that the open innovation paradigm considers two different modes of open innovation. The "inbound" mode of innovation, meaning information that is used by a company but is originated from an external source and the "outbound" mode, concerning information that is leaving the boundaries of the firm (West and Bogers, 2014). As we consider information from patents and standards as well as from active patenting and standardization, this paper mainly contributes to the former mode. In their review of 291 scientific publications related to open innovation, West and Bogers (2014) found the inbound strand to make up the majority of these articles. A reason for this might be the ever increasing availability of external knowledge as a consequence of the improvement of information and communication technologies (Grimpe and Sofka, 2009). While using information from patents and standards clearly represents an inbound of information, the case is not that obvious for patenting and active participation in standardization activities. With respect to active standardization an inbound of information takes place as participants in the standard setting process are often required to disclose relevant information (Lerner and Tirole, 2014). At the same time this disclosure leads to an outbound of information on own innovative activities, which in turn could lead to benefit others, including competitors. With respect to patenting a different picture presents itself. While we have an outbound of information, when patents are published, there is no further inbound or outbound of information due to cooperation of different partners. Thus, openness to external actors whether by patenting or standardization, constitutes a risk (Chesbrough, 2006).

Firms can potentially use a large variety of sources of innovation, e.g. suppliers, lead-users, universities (von Hippel, 1988), competitors (Laursen and Salter, 2006), and internal knowledge (Katila and Ahuja, 2002). Laursen and Salter (2006) show that firms that search more widely ("breadth") and deeply ("depth") have a higher probability to exhibit higher innovation performance. Nevertheless, they find that the returns are decreasing with the number of sources used, indicating that a level of external sourcing can be reached, at which it becomes unproductive to further intensify the effort. The relationship between the number of sources and the innovation performance therefore takes an inverted U-shape. They argue that each separate search space has different institutional norms, habits, and rules. This would in turn mean that pertinent organizational practices are needed to effectively use those sources which require extensive effort to build. Their findings therefore support the findings of Katila and Ahuja (2002), who also find an inverted U-shape relation between innovative performance and search behavior. Reasons for this over-searching were defined by Koput (1997). He presents three arguments for the negative impact of extensive search on innovation performance. First, there might be an amount of information present that is too much for an organization's capacity, second, a potentially bad timing and third, that the firm might be unable to allocate needed attention to the actually valuable information.

Firms differ in their potential to identify and acquire external knowledge that could lead to increased innovative performance (Zahra and George, 2002). Cohen and Levinthal (1990) coin this potential absorptive capacity. They argue that the absorptive capacity of a firm is mainly determined by prior related knowledge. Thus, they tie absorptive capacity to internal R&D activities, because they increase the firms' knowledge stock and ability to adopt knowledge from external sources. West and Bogers (2014) sum up the existing literature on the relation of absorptive capacity and external knowledge sources in two hypotheses. First, the probability to use existing external knowledge sources increases with higher absorptive capacity. Second, firms with higher absorptive capacity have a higher potential to capitalize on those sources. In this paper we will focus on the second aspect: Is the impact of standards and patents on the innovative performance of firms influenced by their absorptive capacity, i.e. R&D investment? Although the conceptual link between absorptive capacity and innovation performance seems plausible, findings in the literature of the past years are ambiguous. On the one hand, the majority of studies find a positive link between absorptive capacity and innovation performance (Rothaermel and Alexandre, 2009; Frenz and Ietto-Gillies, 2009), the timing and quality of search outcomes (Fabrizio, 2009) and the attainment of knowledge especially from customers (Grimpe and Sofka, 2009). On the other hand, although expecting otherwise, Laursen and Salter (2006) discovered that the positive impact of breadth and depth of the search for innovation on innovation performance is diminished by higher R&D intensity. They mainly explain their finding with the not-invented-here (NIH) phenomenon, which predicts a lower acceptance of external innovations by internal technical staff. West and Bogers (2014) argue that managers may substitute internal R&D by external search, resulting in potentially decreased internal innovation capabilities to effectively evaluate and integrate knowledge from external sources. Grossmann et al. (2015) find that using patent applications and proposed standard setting processes as information sources for innovation activities can be used as substitute for own development processes. Vega-Jurado et al. (2009) discover that internal R&D is positively related to the extent to which a firm uses external scientific sources of information. In the same study they further find that internal R&D is simultaneously not necessarily associated with an increased ability to capitalize on that information. This led West and Bogers (2014) to formulate their hypothesis of a substitution effect, i.e. firms with lower levels of R&D increase their external sourcing or sourcing effectiveness. We argue that patent applications and proposed standard setting processes as information sources for innovation activities can be used as substitute for own development processes.

Marsili and Salter (2005) identify a difference in the performance differences that seem to be generated by innovations with different degrees of novelty, as radical innovation seems to be associated with higher performance differences than incremental innovations. Many studies have revealed that the level novelty of innovations is important for the impact of different determinants of innovation performance (Garcia and Calantone, 2002). Nevertheless, the literature on the interrelation of patents and standards as knowledge sources and their impact on the performance of innovation with different degrees of novelty is sparse. While patents constitute knowledge with a high degree of novelty, standards rather reflect the state of the art. In this study, we therefore look at the different influences of patents and standards with respect to their impact on innovations with different degrees of novelty.

Already Laursen and Salter (2006) admit that their approach does not allow not explicitly analyze the relationships within separate knowledge domains. Grimpe and Sofka (2009) find that only limited insight exists in the complementary or substitutive nature of using different external sources. They argue that firms need to be able to single out the most important sources of external knowledge to be able to efficiently address their absorptive capacities. This view is supported by Frenz and Ietto-Gillies (2009), who state that both for strategic management decisions and shaping governmental innovation policies, a deeper understanding of the importance of different knowledge sources for the innovation activities of firms is important. Combining this line of argument with the reasons of limited absorptive capacity and the fact that the role of patents and standards in the open innovations context is heavily under-researched, clearly shows the importance to shed light on the impact of patents and standards as specific sources of external knowledge.

Consequently, our paper will contribute to the existing literature on open innovation by elaborating the previous literature with respect to the following aspects. First, using the Mannheimer Innovation Panel allows us to consider patents and standards as separate search spaces. Second, we complement the dataset with information about the standardization activities of German companies recorded at the German Institute for Standardization (DIN e.V.). This allows us to look at the interrelation of active participation in patenting and standardization as well as the use of patents and standards as external knowledge sources and their impact on innovative performances. Third, the dataset contains information on the percentage of overall turnover generated by innovations with different degrees of novelty – allowing us to investigate the role of patents and standards for the success of innovations with different levels of novelty. Fourth, the availability of R&D expenditure data gives us the opportunity to investigate sourcing strategies of non-R&D firms.

3 Hypotheses

Patents haves been used as a knowledge source for strategic technology management (Ernst, 2003), i.e. for monitoring competitors and technology, managing the own R&D portfolio and identifying potential sources for acquiring external knowledge via mergers and acquisitions, but also recruiting scientists and engineers. Consequently, Toedtling et al. (2009) find that companies relying on patents generate more advanced innovations. Recently, Hsu and Ziedonis (2013) find empirical support that patents do not only serve their well-known role as legal safeguards in product markets, but also as quality signals to improve access and the terms of trade in factor input markets.

Blind and Gauch (2009) have developed an integrative approach of research and standardization highlighting the different functions of standards in basic and applied research, followed by Grossmann et al. (2016), who link patenting and standardization to the various phases of New Product Development. Consequently, we derive our first hypothesis:

H1: Using external knowledge from standards and patents is positively related to innovative performance.

Besides just using standards and patents as pure information sources, companies can use patenting and active participation in standardization as appropriation instruments (James et al., 2013; Somaya, 2012). Specifically, related to patents, we expect a substitutive relationship, whereas active participation in standardization and using standards as an information source are expected to be complementary instruments to foster companies' innovation success. We argue in this line, since we assume that companies engaged in patenting cannot gain the same amount of additional knowledge from patents as companies that are not actively patenting, because they generate a lot of the potentially relevant knowledge in their own innovation process. Firms active in standardization are disclosing detailed information on their innovations to other market participants as they are frequently required to disclose information about own technologies in general and relevant patents in particular (Lerner and Tirole, 2014). Thus, we expect firms to benefit from using this knowledge. Standardization provides a potential for knowledge spillovers (Blind and Mangelsdorf, 2013). In contrast to patenting, active participation in standardization requires an actual collaboration of various actors. Therefore, we argue that participation in standardization increases the potential to appropriate knowledge spillovers. Consequently, we postulate the following second hypothesis:

H2: Solely relying on patents and/or standards as information sources without actively participating in their generation process is positively related to innovation performance. Firms, which are actively patenting, are benefiting less from external knowledge generated by patents. Firms that are actively participating in standardization, however, are benefiting from external knowledge generated by standards.

Expenditures for R&D can be regarded as input of the innovation process, while product or services new to the market ("successful innovations") represent the output of R&D. However, companies can be successful in innovation without spending resources for R&D (Rammer et al., 2009), if they manage external knowledge sources appropriately. Whereas Rammer at al. (2009) focus on innovation and human resource management as compensation of lacking R&D activities, we stress the role of patents and standards as external and codified knowledge sources. Patent applications and proposed standard setting processes as information sources for innovation activities can be used as substitute for own development processes (Grossmann et al., 2015). Additionally, Vega-Jurado et. al. (2009) find that internal R&D is positively related to the extent to which a firm uses external scientific sources of information, but at the same time is not necessarily associated with an increased ability to capitalize on this information. Therefore, we arrive at the following third hypothesis:

H3: Firms, which are not conducting own R&D, are benefiting more from external knowledge generated by patents and standards.

Finally, we distinguish the type of information contained in patents and standards. Patents have to show novelty as patentability requirement, i.e. an invention is not new and therefore not patentable if it was known to the public before the date of the patent application. Thus, patents contain knowledge with a high degree of novelty. In contrast, standards have just to reflect the current state of the art, i.e. they can also include already existing prior art, and are the result of a consensus driven negotiation process. Consequently, both knowledge sources represent two levels of novelty, which have different impacts on radical and incremental innovations. Based on these considerations, we derive the fourth hypothesis:

H4: While patents compared to standards are a more relevant source for external knowledge with respect to radical innovations, the opposite is true for incremental innovations.

4 Data and Methodology

4.1 Sample

In order to obtain a dataset which allows testing the developed hypotheses, data from the Mannheim Innovation Panel (MIP) is matched with information about the standardization activities of German companies recorded at the German Institute for Standardization (DIN e.V.). The MIP is conducted yearly by the Centre for European Economic Research in Mannheim (ZEW) since 1995, representing the Community Innovation Survey (CIS) for Germany. Although the MIP only includes companies with five or more employees, it is considered as representative for the corporate landscape in Germany. It contains information about the successful introduction of new products or services into the market, patenting activities as well as expenditures on research and development. Furthermore, some additional information about companies' background characteristics such as turnover and sector affiliation are available. We use the 2013 wave of the survey as it contains a special set of questions related to internal and external sources of knowledge used in the innovation process of the respective companies in the years 2010 to 2012. More explicitly, two of the sources were patents and standards, making this dataset a perfect basis for our analysis. The initial dataset is comprised of 8,740 observations. We were able to match the data about the participation in standardization to the dataset. Overall 578 companies in the initial sample were active in the standardization process. Due to non-response in some of the model variables the number of observations used to estimate our models reduces to 2,509.

4.2 Variables

4.2.1 Dependent variables

We use six variables from the MIP dataset as proxies to reflect the innovative success of a firm. First, the percentage of a firm's overall turnover generated by new or distinctly improved products or services (INN) in 2012. To test whether the impact of the two knowledge sources varies for different levels of radicalness, that is to test hypothesis H4, we include two additional proxies. Following Laursen and Salter (2006), we include the percentage of a firms overall turnover induced by innovations new to the firm (INNFIRM) in 2012, to account for incremental innovations. Additionally, we include the percentage of a firms overall turnover induced by innovations new to the world (INNWORLD) in 2012, representing radical innovations. To allow for an alternative model specification, we further include three binary variables indicating if a firm introduced any product or process innovations (INND), innovations new to the firm (INNFIRMD) and new to the world (INNWORLDD).

4.2.2 Independent variables

In the survey, respondents were asked to rate the importance of different internal and external knowledge sources for their innovation activities on a Likert scale of 0 (not used) to 3 (high). Fortunately, the sources patents and standards were asked separately, allowing us to construct two separate variables. USEPATENT and USESTANDARD are binary variables that are 1 if the respective source was of at least some importance for the innovation process of a firm and 0 otherwise. Although some information about the importance of the sources are lost in the following estimation step, binary coding of Likert scale variables might reduce potential measurement error (Cohen and Malerba, 2001). In this paper we are more interested in the impact of using those sources in general than the extent to which they are used, which would pose a slightly different research question. As a first robustness check, we include the original Likert scale coded variable and found the results confirmed. To model the impact of active participation in patenting and standardization we include the two dummy variables PATENT and STANDARD. To test hypothesis H2, we include an interaction term of USEPATENT and PATENT as well as of USESTANDARD and STANDARD. Frenz and Ietto-Gillies (2009) find a positive impact of in-house R&D and innovation performance. To account for this influence, we include a binary variable (RD) that is 1 if a firm has conducted R&D in the period 2010-2012 and 0 if otherwise. Finally, including interaction terms of RD with USEPATENT and USESTANDARD will allow us to test hypothesis H4.

4.2.3 Control Variables

To control for differences in the capacity to absorb and process new knowledge, we use the share of employees with college degree (EDUC) on a scale from 1 to 100. The impact of the size of the market a firm is serving is expected to positively influence the innovativeness of a firm (Acemoglu and Linn, 2004). Thus, we use a variable (MARKET) which takes on the values 1 to 4 depending on the market to which the largest proportion of sales can be attributed to (1=local, 2=national, 3=EU countries and 4= international). Lööf and Broström (2008) have shown a positive influence of cooperation between industry and university. The same relation was shown to be true for horizontal cooperative strategies (Kotabe and Swan, 1995). Therefore, we control for cooperation in the innovation process by employing a dummy variable (COOP) that is 1 if the company actively participated in any kind of R&D or innovation cooperation. As larger firms are expected to have access to more resources, the natural logarithm of the number of employees (LOGEMP) is used to proxy firm size. Firms that belong to a larger group of companies could have an advantage due a facilitated access to knowledge and other resources inside the group of firms. A binary variable indicates the affiliation to a group of companies (GROUP). We control for industry specific differences in the innovation performance using 13 binary variables based on the NACE two-digit level classification, considering only the manufacturing industry. Descriptive statistics for the variables defined above and a brief description of the industry sectors are given in Table 1.

Table 1 Descriptive statistics

VARIABLES	N	mean	sd	min	max
Dependent Variables					
INN	2509	10.56199	19.81234	0	100
INND	2509	.5213232	.4996447	0	1
INNFIRM	2461	2.732966	8.883429	0	100
INNFIRMD	2509	.2514946	.4339587	0	1
INNWORLD	1720	1.835406	8.148895	0	100
INNWORLDD	1720	.1651163	.3713934	0	1
Independent Variables					
USESTANDARD	2509	.2766042	.4474082	0	1
STANDARD	2509	.0677561	.251377	0	1
USESTANDARD x STANDARD	2509	.0434436	.2038942	0	1
USEPATENT	2509	.2805899	.449377	0	1

PATENT	2509	.382224	.4860277	0	1
USEPATENT x PATENT	2509	.2367477	.4251709	0	1
R&D	2509	.3953766	.4890289	0	1
MARKET	2509	1.944599	.8207096	1	4
EDUC	2509	14.85227	19.50289	0	100
COOP	2509	.2403348	.4273719	0	1
GROUP	2509	.284177	.4511114	0	1
LOGEMP	2509	3.60942	1.514927	.6931472	10.6515
SECTOR 0 (Nace 10, 11, 12)	2509	.0071742	.0844129	0	1
SECTOR 1 (13, 14, 15)	2509	.1307294	.3371713	0	1
SECTOR 2 (16, 17, 18)	2509	.0530092	.2240964	0	1
SECTOR 3 (19)	2509	.0163412	.1268091	0	1
SECTOR 4 (20)	2509	.0358709	.1860052	0	1
SECTOR 5 (21)	2509	.0322838	.176788	0	1
SECTOR 6 (22, 23)	2509	.0725389	.2594298	0	1
SECTOR 7 (24, 25)	2509	.1239538	.3295945	0	1
SECTOR 8 (26)	2509	.048625	.2151256	0	1
SECTOR 9 (27)	2509	.0290953	.1681071	0	1
SECTOR 10 (28)	2509	.1363093	.3431851	0	1
SECTOR 11 (29, 30)	2509	.1323236	.3389098	0	1
SECTOR 12 (31, 32, 33)	2509	.1817457	.3857117	0	1

4.3 Econometric Model

For the binary dependent variables INND, INNFIRMD and INNWORLDD a standard logistic regression approach is used. The dependent variable INN measures a percentage. Hence, by definition, we observe a corner solution at 0 and 100, respectively. The same holds true for the model specifications where INNFIRM and INNWORLD are used as dependent variables. While we have naturally very few observations where the percentage is equal to 100, the percentage of observations with a left corner solution ranges from 57% for INN over 57.2% for INNWORLD to 74.5% for INNFIRM. Following Greene (2000), a Tobit regression model is used for those model specifications. In contrast to the standard OLS regression, the consistency of the Tobit model is based on the normality of the residuals. Unfortunately, for our model specification this assumption is violated. Following Laursen and Salter (2006), who base their model on the same dependent variables and are following several other studies facing the same problem (e.g. Papalia and Di Iorio, 2001), we use a log-transformation of the Tobit model, assuming a lognormal distribution of the residuals. Hence, a latent variable INN* for the observed variable INN is introduced: $INN^* = \ln(1 + INN)$. The same transformation is applied for INNFIRM and INNWORLD.

Our basis model can be defined as:

$$INN_i^* = \beta_1 USESTANDARD_i + \beta_2 USEPATENT_i + \sum_{j=1}^{k} \gamma_j CONTROL_{ij} + u_i$$

were INN_i^* is the innovative performance of firm i, $USESTANDARD_i$ and $USEPATENT_i$ are the explanatory binary variables for firm i described in the previous section, $CONTROL_i$ is the set of k control variables described above and u_i is the error term. The parameter estimates of β_1 and β_2 will allow us to test hypothesis H1. In a second step, we add the binary variables indicating the active participation in patenting and standardization, as well as their interaction terms with the variables indicating the use of information from those sources. This allows us to test hypothesis H2.

$INN_i^* = \beta_1 USESTANDARD_i + \beta_2 USEPATENT_i + \beta_3 STANDARD_i + \beta_4 PATENT_i + \beta_3 STANDARD_i * USESTANDARD_i + \beta_4 PATENT_i * USEPATENT_i + \sum_{j=1}^{k} \gamma_j CONTROL_{ij} + u_i$

To test hypothesis H3, i.e. to test whether the extent to which knowledge from patent and standards influences the innovation performance differs depending on the R&D efforts, we implement an interaction term with the R&D dummy variable.

$INN_i^* = \beta_1 USESTANDARD_i + \beta_2 USEPATENT_i + \beta_3 RD_i * USESTANDARD_i + \beta_4 RD_i * USEPATENT_i + \sum_{j=1}^{k} \gamma_j CONTROL_{ij} + u_i$

In a final step, to test hypothesis H4, we contrast our results from the last equation with regressions using INNFIRM and INNWORLD as dependent variables.

$INNFIRM_i^* = \beta_1 USESTANDARD_i + \beta_2 USEPATENT_i + \beta_3 RD_i * USESTANDARD_i + \beta_4 RD_i * USEPATENT_i + \sum_{j=1}^{k} \gamma_j CONTROL_{ij} + u_i$

$INNWORLD_i^* = \beta_1 USESTANDARD_i + \beta_2 USEPATENT_i + \beta_3 RD_i * USESTANDARD_i + \beta_4 RD_i * USEPATENT_i + \sum_{j=1}^{k} \gamma_j CONTROL_{ij} + u_i$

As a first robustness check, we run all Tobit regressions above on the constructed binary dependent variables INND, INNFIRMD and INNWORLDD using a logistic regression approach.

5 Results

5.1 Descriptive analyses

On average, new or distinctly improved products or services accounted for approximately 10.56% of the overall turnover in our sample. Products that were new to the firm and products new to the world accounted for 2.73% and 1.84%, respectively. The binary indicators INND, INNFIRM and INNWORLD that report if the firm was able to introduce the respective category of innovations at all, shows a clear and expected picture. While 52.13% of the firms in the sample were able to introduce at least one product or process innovation (incremental or radical), only about a quarter of the firms was able to report innovations new to the firm and 16.51% innovations new to the market. With respect to our main explanatory variables, the data support our expectations with respect to the active participation. While 38.22% of the firms are patenting, only 6.78% actively participate in standardization. On the other hand, standards (27.66%) are almost as important as patents (28.06%) when it comes to the source of information for the innovation process.

Table 2 contains the share of firms in our sample that is using the two information sources depending on their active participation in the respective category. 170 of the firms in our sample are active in standardization, while 959 firms reported to be actively patenting. As expected, firms that are active in the relevant category are more likely to use the corresponding information source. Nevertheless, there is one major difference. 81.37% of the firms active in patenting are using patents as an information source, while only 64.11% of the firms active in standardization use standards as an external knowledge source. In contrast, only 7.1 of firms use patents as an information source when they are not patenting, opposed to 25.01% of the firms that are not actively participating in standardization, but use it as an external knowledge source. This indicates that information from standards are more relevant to firms not actively participating in either standardization or patenting – 10.84% and 6.94%, respectively.

Table 2 Percentage of firms that use the external knowledge sources depending on their participation in the respective category

	Active participation	No active participation
USESTANDARD	64.11	25.01
USEPATENT	81.37	7.1

In a last step we look at the difference in the external knowledge sourcing behavior for firms actively conducting R&D and SMEs versus non-SMEs (see Table 3). Following the recommendation of the European Union, we classify firms with less than 250 employees as SMEs. Thus, SMEs make up 89.31% of our sample. Obviously, R&D conducting firms, as well as non-SMEs are using knowledge from standards and patents to a greater extent. We observe practically no difference in the relevance of patents and standards for SMEs and firms conducting R&D. For non-R&D firms on the other hand, standards seem to be more relevant, while for larger firms patents seem to of higher importance.

Table 3 Percentage of firms that use the external knowledge sources depending on their status

	R&D	No R&D	SME	Non-SME
USESTANDARD	52.21	11.60	23.91	58.95
USEPATENT	57.56	8.77	23.78	63.80

5.2 Model estimation results

The estimation results are available from the authors upon request.

One aspect, which is not included in the latter analyses, is the degree of radicalness of the innovations introduced. This is due to the fact that we measured innovativeness as the share of new or incrementally improved products in overall sales. Nevertheless, it would be interesting to see if the impact of the two knowledge sources differs for more radical innovations. To test our fourth hypothesis, we therefore rerun the regressions for Model (1), (2) and (3), replacing our dependent variable INN by INNFIRM and INNWORLD respectively. Table 6 reports the regression results. The results for Model (7) show that knowledge from standards and patents is still positively associated with higher innovative performance with respect to radical innovations. The coefficients for USESTANDARD however, are not significant anymore, indicating that standards are not relevant for more radical innovations. This result holds true if we take the active participation in standardization and patenting into account. In contrast, once we incorporate R&D activities of the firms, the picture changes considerably. Like in Model (3), knowledge from standards and patents is highly important for firms that are not actively conducting R&D. For firms conducting R&D, knowledge from patents is an important source of information, while knowledge from standards does not add any value. The different results for Model (7) – (10) compared to Model (1) and (2) with respect to standards, provide some evidence for our fourth hypothesis. The definition of INN incorporates all innovations, without considering their radicalness. We assume that the different effect between the models is triggered by the fact that model (1) and (2) allow for incremental innovations, while Models (7) – (10) only represent more radical innovations. Thus, we interpret the differences as support for our hypothesis. With respect to the qualitative interpretation of the control variables, the results from Table 4 remain unchanged.

Table 4 shows the results of the Tobit regression model. Model (1) clearly shows a positive and significant relationship between the use of the two considered knowledge sources and the innovative performance. Thus, we find strong support for our first hypothesis. In Model (2) we add four variables to account for the active participation in patenting and standardization and the interaction effects with the respective information sources. This allows us to test our second hypothesis. The results in The estimation results are available from the authors upon request.

One aspect, which is not included in the latter analyses, is the degree of radicalness of the innovations introduced. This is due to the fact that we measured innovativeness as the share of new or incrementally improved products in overall sales. Nevertheless, it would be interesting to see if the impact of the two knowledge sources differs for more radical innovations. To test our fourth hypothesis, we therefore rerun the regressions for Model (1), (2) and (3), replacing our dependent variable INN by INNFIRM and INNWORLD respectively. Table 6 reports the regression results. The results for Model (7) show that knowledge from standards and patents is still positively associated with higher innovative performance with respect to radical innovations. The coefficients for USESTANDARD however, are not significant anymore, indicating that standards are not relevant for more radical innovations. This result holds true if we take the active participation in standardization and patenting into account. In contrast, once we incorporate R&D activities of the firms, the picture changes considerably. Like in Model (3), knowledge from standards and patents is highly important for firms that are not actively conducting R&D. For firms conducting R&D, knowledge from patents is an important source of information, while knowledge from standards does not add any value. The different results for Model (7) – (10) compared to Model (1) and (2) with respect to standards, provide some evidence for our fourth hypothesis. The definition of INN incorporates all innovations, without considering their radicalness. We assume that the different effect between the models is triggered by the fact that model (1) and (2) allow for incremental innovations, while Models (7) – (10) only represent more radical innovations. Thus, we interpret the differences as support for our hypothesis. With respect to the qualitative interpretation of the control variables, the results from Table 4 remain unchanged.

Table 4 indicate that exclusively relying on the knowledge sources is positively influencing the innovation performance. The sole participation on the other hand has a significantly positive effect for patenting and a – surprisingly - significantly negative effect for standardization. This may be explained by the fact that patenting is securing an intellectual property right on an innovation and is expected to generate financial returns, i.e. measured by the turnover of innovative products, for the own firm. On the other hand, only passively participating in the standardization process, i.e. without using the generated information, seems to be negatively related to the innovativeness of a firm. This could have at least two explanations. First, passive participation imposes costs that reduce the amount of resources available for internal innovation activities. Second, one could argue that firms do not use standards as knowledge sources because they lack absorptive capacity, indicating lower innovation potential. The significant and negative coefficient for the interaction term for USEPATENT and PATENT supports our second hypothesis that firms benefit more from this knowledge source if they are not actively patenting. This possibly stems from the fact, that firms active in patenting cannot gain substantial additional knowledge from patents, as they generate a lot of the potentially relevant knowledge in their own innovation process. With respect to standards, the opposite effect seems to be indicated by the positive interaction effect of STANDARD and USESTANDARD, i.e. the negative effect of exclusive participation is compensated by the knowledge inflow. However, the coefficient is not statistically significant. Thus, we find evidence to support our second hypothesis with respect to patents. Although the results support our assumptions with respect to standards to some extent, the result is not statistically significant. Finally, Model (3) allows us to test our third hypothesis. Firms conducting no own R&D are benefiting more from using patents and standards as information sources, than firms that are conducting R&D. Again, the coefficients for USESTANDARD and USEPATENT are significant and positive, meaning that using information from those sources without conducting R&D is positively related to innovation performance. Firms conducting own R&D in comparison, do not benefit as much from using standards as an external knowledge source as indicated by the negative and significant coefficient for the respective interaction term. For patents a different picture presents itself. Although the negative coefficient for the interaction term indicates that R&D conducting firms benefit less from knowledge from patents, the effect is not statistically significant. Hence, we find only partial evidence for our third hypothesis – this time with respect to standards.

Regarding the control variables, all coefficients show the expected signs, except for GROUP which was expected to be positively related to the innovation performance. Nevertheless, the coefficient is only hardly significant and only for model (2). Own R&D seems to be the most important determinant of innovation success. As a first robustness test, we estimated the model specifications (1) – (3) using the binary dependent variable INND, applying a logit regression approach. Most of the results described above remain valid. One difference however, is the significant and positive parameter estimate for the size proxy. This indicates that the size of a firm is a relevant determining factor to be innovative at all, while it seems to be irrelevant for the share of those innovative products in overall sales. Another difference and perhaps the most important one, is that the negative coefficient for the active participation in standardization is not significantly negative anymore. From this we can infer that while active standardization is negatively associated with the innovation performance measured by INN, it has no significantly detrimental effect on the probability to successfully innovate at all. The estimation results are available from the authors upon request.

One aspect, which is not included in the latter analyses, is the degree of radicalness of the innovations introduced. This is due to the fact that we measured innovativeness as the share of new or incrementally improved products in overall sales. Nevertheless, it would be interesting to see if the impact of the two knowledge sources differs for more radical innovations. To test our fourth hypothesis, we therefore rerun the regressions for Model (1), (2) and (3), replacing our dependent variable INN by INNFIRM and INNWORLD respectively. Table 6 reports the regression results. The results for Model (7) show that knowledge from standards and patents is still positively associated with higher innovative performance with respect to radical innovations. The coefficients for USESTANDARD however, are not significant anymore, indicating that standards are not relevant for more radical innovations. This result holds true if we take the active participation in standardization and patenting into account. In contrast, once we incorporate R&D activities of the firms, the picture changes considerably. Like in Model (3), knowledge from standards and patents is highly important for firms that are not actively conducting R&D. For firms conducting R&D, knowledge from patents is an important source of information, while knowledge from standards does not add any value. The different results for Model (7) – (10) compared to Model (1) and (2) with respect to standards, provide some evidence for our fourth hypothesis. The definition of INN incorporates all innovations, without considering their radicalness. We assume that the different effect between the models is triggered by the fact that model (1) and (2) allow for incremental innovations, while Models (7) – (10) only represent more radical innovations. Thus, we interpret the differences as support for our hypothesis. With respect to the qualitative interpretation of the control variables, the results from Table 4 remain unchanged.

Table 4 Tobit regression results

Model	(1)	(2)	(3)
Dependent Variables	INN	INN	INN
Independent Variables	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)
USESTANDARD	0.754***	0.606***	2.265***
	(0.146)	(0.146)	(0.267)
USEPATENT	0.401***	0.856***	0.581*
	(0.155)	(0.264)	(0.299)
STANDARD		-0.729**	
		(0.364)	
PATENT		1.739***	
		(0.163)	
USESTANDARD x STANDARD		0.223	
		(0.429)	
USEPATENT x PATENT		-1.128***	
		(0.289)	
USESTANDARD x RD			-2.275***
			(0.316)
USEPATENT x RD			-0.346
			(0.341)
RD	2.629***	2.096***	3.357***
	(0.149)	(0.149)	(0.171)
MARKET	0.246***	0.189***	0.244***
	(0.0745)	(0.0733)	(0.0736)
EDUC	0.0103***	0.00887***	0.0107***
	(0.00301)	(0.00294)	(0.00297)
GROUP	-0.230	-0.230*	-0.176
	(0.141)	(0.138)	(0.139)
COOP	0.677***	0.579***	0.664***
	(0.141)	(0.137)	(0.138)
LOGEMP	-0.0166	-0.0249	-0.000145
	(0.0453)	(0.0454)	(0.0448)
Constant	-1.871***	-1.932***	-2.166***
	(0.265)	(0.262)	(0.267)
Industry dummies	yes	yes	yes
No. of obs	2509	2509	2509
No. of left-censored obs	1430	1430	1430
No. Of right censored obs	25	25	981
Log likelihood	-3058	-2995	-1567
Chi-Square	1253	1378	1251
Pseudo R^2	0.170	0.187	0.285

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 Tobit regression results - radicalness

Model	(7)	(8)	(9)	(10)	(11)	(12)
Dependent Variables	INNFIRM	INNWORLD	INNFIRM	INNWORLD	INNFIRM	INNWORLD

Independent Variables	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)	Coefficient (S.E.)
USESTANDARD	0.259	-0.0580	0.0644	-0.189	1.102***	1.309**
	(0.189)	(0.227)	(0.192)	(0.232)	(0.399)	(0.591)
USEPATENT	0.498**	0.838***	1.089***	0.819*	0.904**	1.029*
	(0.199)	(0.239)	(0.349)	(0.477)	(0.435)	(0.614)
STANDARD			-1.079**	-0.378		
			(0.506)	(0.481)		
PATENT			1.661***	1.665***		
			(0.220)	(0.280)		
USESTANDARD x STANDARD			1.094*	0.193		
			(0.583)	(0.569)		
USEPATENT x PATENT			-1.218***	-0.452		
			(0.378)	(0.503)		
RD x USESTANDARD					-1.160**	-1.690***
					(0.450)	(0.639)
RD x USEPATENT					-0.577	-0.396
					(0.481)	(0.657)
RD	2.399***	2.719***	1.924***	2.052***	2.851***	3.273***
	(0.205)	(0.263)	(0.206)	(0.265)	(0.234)	(0.308)
MARKET	0.228**	0.649***	0.181*	0.602***	0.232**	0.662***
	(0.0987)	(0.107)	(0.0985)	(0.106)	(0.0986)	(0.108)
EDUC	0.00771**	0.0166***	0.00624	0.0150***	0.00788**	0.0173***
	(0.00390)	(0.00453)	(0.00388)	(0.00448)	(0.00389)	(0.00453)
GROUP	0.994***	0.994***	0.896***	0.879***	0.985***	0.992***
	(0.179)	(0.205)	(0.177)	(0.200)	(0.178)	(0.203)
COOP	-0.533***	-0.104	-0.544***	-0.102	-0.488***	-0.0450
	(0.187)	(0.215)	(0.186)	(0.212)	(0.186)	(0.214)
LOGEMP	0.0403	0.0309	0.0271	0.0132	0.0473	0.0360
	(0.0600)	(0.0686)	(0.0610)	(0.0698)	(0.0599)	(0.0684)
Constant	-4.044***	-5.178***	-4.144***	-5.179***	-4.266***	-5.490***
	(0.384)	(0.477)	(0.386)	(0.480)	(0.391)	(0.497)
Industry dummies	yes	yes	yes	yes	yes	yes
No. of obs	2461	1720	2461	1720	2461	1720
No. of left-censored obs	1878	1436	1878	1436	1878	1436
No. Of right censored obs	6	5	6	5	6	5
Log likelihood	-1955	-814.0	-1924	-791.7	-1946	-804.0
Chi-Square	650.5	799.8	713.6	844.4	670.0	819.6
Pseudo R^2	0.143	0.329	0.156	0.348	0.147	0.338

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6 Conclusion

This paper explores the impact of using patents and standards as knowledge on innovation success. Our analysis contributes to the research about the role of external knowledge sources for firms' innovation performance by confirming the similarities, but also the differences between patents and standards as knowledge sources. On the one hand we find that both have in general a positive impact on companies' innovativeness. On the other hand, there are differences if we control for the active usage of both instruments, i.e. patenting and active participation in standardization. Both, patents and standards, are important for the innovativeness of firms not actively patenting or standardizing. Nevertheless, while standards do not seem to be of less importance for firms active in standardization, patents are of more importance for firms not actively patenting. Furthermore, standards are obviously a very important source for innovation if companies do not perform own R&D. Finally, patents are more relevant for radical innovation, whereas standards seem to support more efficiently incremental innovation.

It needs to be pointed out that the results in this paper do not allow us to make causal statements. Although our research is based on a large representative dataset of German manufacturing firms, at this point in time only cross-sectional data is available to analyze the research questions at hand. Thus, one aspect of further research would be to readdress the questions using panel data once they become available.

The results can be viewed from an innovation economics and innovation management point of view. Since companies without in-house R&D are highly restricted in the scope of developing new knowledge on their own, complementing their own technology resources with external knowledge, like patents and standards, widens their opportunities to successfully develop products and processes.

Our results have some relevance for innovation policy. First, the strong focus on promoting in-house R&D often to be found in innovation policy has to be complemented by supporting access to external knowledge sources, like patents and standards. Since using these external knowledge sources can compensate for missing in-house R&D, policy may try to identify likely barriers in companies preventing them from effectively using them.

Consequently, our results have implications both for companies' innovation management and policy makers innovation policy. First of all, companies' innovation management will certainly gain by relying stronger on patents and standards as information source, especially if no own R&D is performed. Second, innovation policy in Germany should consider this impact in reconsidering its policy mix.

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Does Open Innovation Necessarily Mean Open Standards?

Amel Charleux, Anne Mione

University of Montpellier – Montpellier Research in Management

amel.charleux@umontpellier.fr, anne.mione@umontpellier.fr

Abstract: *In this contribution we discuss the concept of "openness" and specifically examine the relation between open innovation and open standards. We observe the sector of open source software. In this sector we distinguish different business models enabling to create and capture value. We then relate each business model type to different nature of standards*

The method is realized in two stages. First, through a quantitative analysis of 200 open source editors, we identify a taxonomy describing the firms' strategic choices between the openness for value creation, and closure for appropriation interests. Second, thanks to a case study of three editors, we explore the relation between these business models and the choice of the technical standards that are implemented to develop the software. We use West's graduation to qualify the standards' openness. Our results show that the more the firm is "open oriented", the more the technical standard is "open". At the same time, the more the firm is "profitability oriented", the more dominant is the technical standard implemented. We thus contribute to a better understanding of the relation between open standard and open innovation.

1 Introduction

As compared to the interest provoked by the relation between standardization and innovation, relatively few studies claimed for the importance of studying standardization in the context of open innovation (West, 2003). This is all the more surprising whereas innovation and standardization are the two facets of economic vitality (Viardot, Sherif, & Chen, 2016) and as recent researches by standardization researchers have admitted that a standardization phase seems inextricably linked with the innovation process (Viardot et al., 2016). Building on this tight relation between standardization and innovation, we intend to contribute to the analysis of the standard's role in open innovation.

We specifically observe that the emergence of the "open standard" concept does not really help to understand the strategic decision relating to standards in the concept of open innovation. In our mind, the relation between "open standard" and "open innovation" needs to be discussed. Indeed, in this concept, both elements are unclear: "standards" may mean a specification, an interface dispositive, or systems whereas "open" is interpreted differently in a formal standardization perspective or in open innovation context. The objective of this contribution is to clarify the different natures of standards applying in open innovation context. We study the particular sector of open source software industry because it represents the archetypal model of open innovation that Chesbrough calls open source innovation (Chesbrough, Vanhaverbeke, & West, 2006). Here, traditional value creation and value appropriation mechanisms seem ineffective because of the massive collaboration. New ways of doing business appear depending on the more or less open strategy of actors. We thus argue that open source innovation does not necessarily means adopting "open" pure standards but a more sophisticated strategy composed of standards offering differential levels of openness. Our goal is to enlighten the different strategic decisions relating to these different standards. We specifically intend to show that the choice of technical standards, while developing a software, relates to the business model (BM) adopted by the firms following an open source strategy.

We realize a quantitative analysis of 200 software developed by publishers through open innovation. In doing that, we have two objectives: we intend identifying different business models and then, relate these business models to the implementation of technical standards. For this last purpose, we adopt a case study method and analyse the business model and the standards used for the development of three software, selected in our first sample of 200 software. Our idea is that the choice of technical standards depends upon the business model.

The second part discuss the concept of openness and presents the concept of open innovation and its business implications. We also expose the concept of standard related to openness concern. The third part shows the method. The two last parts present the results and discussion.

2 Open Source Business Models and Open Standards

2.1 Open Innovation, Open Worlds and Open Source Sector

Openness in open innovation refers to a specific mode of innovation where innovation is not secret but shared with others to beneficiate from their contributions. Developed by Chesbrough (2003), this concept has disturbed the traditional "cathedral" model of innovation (Raymond, 1998). The design of an internal, secret and integrated innovation is challenged by a more open model, based on the collective, open and outsourced dimensions, that Raymond (1998) named "bazaar". The new innovation design is at odds with conventional models because it opens the field of possibilities and stimulates more innovation. In this context, companies have to face the issue of appropriating innovation: open innovation suggests the involvement of several actors in the process that find ways to share ownership and the common innovation fruits (West, Salter, Vanhaverbeke, & Chesbrough, 2014). A unique platform, common languages, same references and identified protocols are required to enable different contributors to cooperate and assemble their inputs. From that perspective, standards are required to coordinate these contributions.

Openness in "open worlds" relates to the opposition between proprietary and open systems. This opposition concerns multiple levels of management science: governance, innovation, appropriability and inter-organizational relations. To illustrate these differences, we will take the most emblematic examples of these two worlds: the proprietary software firms vs. the open source software communities. Regarding governance, there are notable differences between the two models: hierarchical and vertical structure for the first, against a horizontal and organic structure for the latter. The openness is based on a certain freedom within the community that allows a high level of exchange and cooperation. This cooperation that can be very intense questions the appropriation possibilities of the firms involved in these communities that depends on the Intellectual Property benefit. In opposition to the copyright of proprietary software, the open source solutions are copylefted, i.e. they are protected and recognized under special licences but they are not owned by their contributors. Finally, in the open source, because the source code (the recipe of a software) is open to all, the relation between competitors is changed, as well as that with customers that can heavily participate to the development process, suppliers, that can do it too… etc. In open worlds like open source software sector, the innovation process is fundamentally different from that of closed worlds. Relying on the power of crowd, the bazaar organisation of communities (Raymond, 1998) led to new ways of innovating that scholars named open innovation (Chesbrough, 2003) and more specifically, open source innovation (Chesbrough et al., 2006; Pénin, 2011). In this context, standards play a key role in allowing or forbidding access for different contributors. They enable or impede complementors to offer compatible components of the main product in the whole system.

Openness in open source sector refers not only to pure modes but also to hybrid modes where the access to the code is open, but some elements, as service, might be proprietary and closed. These hybrid configurations are based on the development - and thus innovation - which is characterized by the importance of the community, the maximum openness of the data and the free access to them. The community is constituted of diverse contributors: private companies, local authorities, individual developers involved in their own name, everyone can contribute. The free character is based on the freedom to access, modify and redistribute the software source code, thanks to specific licenses that specify the freedoms granted by the authors of the software to users. Finally, the free of charge notion is established in two ways: the contribution is based on the voluntary principle; the software is not patented and therefore are eligible for free distribution. These properties require new business models that allow understand how in these opening conditions, companies manage to be profitable.

2.2 Business Models in Open Source Innovation

The business model allows answering in simple terms the question of the creation and appropriation of value (Johnson, Christensen, & Kadermann, 2008). It considers the interdependence between the business model and the revenue model, respectively asking questions of value creation and value appropriation (Zott, Amit, & Massa, 2010). Teece's definition (2010) focuses on how a company delivers value to consumers, encouraging them to pay for that value and converts those payments in profits. It is nothing less than the organizational and financial architecture of a firm (Teece, 2010). Business model questions the profitability that is not only a question of innovating but a question of finding ways to exploit innovation (Chesbrough & Rosenbloom, 2002). This question is even more acute in the case of open source innovation (Chesbrough et al., 2006; Pénin, 2011).

Business models' studies are increasingly paying attention to the interaction between stakeholders for efficiency and/or novelty (Benavent & Verstraete, 2000; Zott & Amit, 2008). Interaction between complementors and between stakeholders is realized mainly by standardization (Almeida, Oliveira, & Cruz, 2011). In open source innovation, this concerns all the contributors that participate to the community software development. As the communities are managed regarding to specific business models in line with specific open strategies, we consider that the choice of conforming to specific standards consists of a strategic arbitrage that needs to be examined. Specifically, standards choices are not considered relatively to business model concept and literature on open standards does not enable to measure the complexity of standard strategy in the open source context.

2.3 Standard's Choices in Open Source Business Models

Openness in literature on standardization covers different meanings. When considering standardization in the large conception of the dominance of a technology over rivals, openness refers to the spread of the knowledge of the technology (Suarez, 2004). The signal of a standardized technology is when it covers more than 50 % of the market (Anderson & Tushman, 1990) and when it dispersed enough that competition is increased and others are able to start copying the technology as they implement it. Less open standards exist when a particular firm has much power (not ownership) over the standard, which can occur when a firm's platform "wins" in standard setting or the market makes one platform most popular.

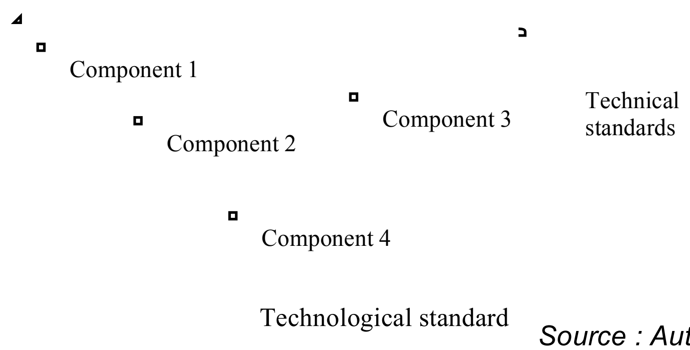
The openness of standards is also claimed by scholars regarding to formal standardization. The formal Standard Setting Organization process enables to produce “open standards” referring to the mode of definition that is public and consensual, to the FRAND (Fair, Reasonable and Non-Discriminatory) policy on intellectual property right and to the interoperability of the specification. The definitions of the term *open standard* used by academics, the European Union and some of its member governments or parliaments such as Denmark, France, and Spain preclude open standards requiring fees for use. On the standard organization side, many definitions of the term *standard* permit patent holders to impose fair terms that may vary from royalty-free to fair, reasonable, and non-discriminatory terms on implementers or users of the standard.

In the specific context of open source software, "open standard" is open only if it can be freely adopted, implemented and extended (Simcoe, 2006). According to West (2004), the openness of a standard is graduated by the level of access to creation of specification, the level of access to results of specification and the level of access to implementation of specification. Many specifications that are sometimes referred to as standards are proprietary and only available under restrictive contract terms (if they can be obtained at all) from the organization that owns the copyright on the specification. As such, these specifications are not considered to be fully *open*. Joel West has argued that "open" standards are not black and white but have many different levels of "openness" (West, 2007). In open source, these levels will impact the community contribution process which is at the heart of value creation. Business implications are thus expected.

Regarding the technological field of our study, the standard type needs to be specified in addition to its openness character.

2.3.1 Technological and Technical Standards

According to ISO, a standard can concern a technology, a protocol, a format or a language. Technological standards aim to insure two key elements of information systems: the compatibility between solutions and the interoperability between systems (David & Greenstein, 1990; Tushman & Rosenkopf, 1992; Weitzel, Beimborn, & König, 2006). Thus, technology standards refer to the interface specifications that ensure communication between components of a system and facilitate coordination among actors (Garud, Jain, & Kumaraswamy, 2002). It refers to a specific technological solution. For example, the GSM technology or the World Wide Web are standardized technologies. But each one is at its turn composed of multiple components that are more technical. For the GSM technology, there is a range of technical standards that enter in composition ((Bekkers, 2001); ETSI, 2007). As de Vries et *al.* (2008) explain, “the concept of standard can be applied at two levels: a technology as a whole and its constituent technical standards”.



Source : Authors

Figure 1. Technological vs. technical standards

Garud & Kumaraswamy (1993) defined technical standards as “codified specifications about components (compatibility) and their relational attributes (interoperability)”. For Tassey (2000), they are “a set of specifications to which all elements of products, processes, formats, or procedures under its justification must conform”. Here, a technical standard is a key element of a technological standard. In the software industry for example, a software as a whole can be considered as technological standard like Internet Explorer or Netscape (de Vries et al., 2008). Then, each software is composed of technical elements like file formats, programming languages and exchange protocols that are potentially standardized. But all technological standards are not composed of technical standards. Sometimes, if the technology is completely disruptive, there can be no technical standards to achieve it. Thus, technical components are critical choices in the technological field. Considering a firm position, to better understand the implications of the distinction between technological and technical standards, it is helpful to distinguish the supply side from the demand side (Narayanan & Chen, 2012). Technical standards are supply side oriented because they are components of a product (Anderson & Tushman, 1990; Clark, 1985; Tassey, 2000; Weiss & Birnbaum, 1989). Technological standards are demand side oriented because they are intended to guarantee consumers the compatibility between their products and other products available on the market (Axelrod, Mitchell, Thomas, Bennett, & Bruderer, 1995; Cusumano, Mylonadis, & Rosenbloom, 1992a). That is the reason why we explore the decisions made concerning technical standards according to the BM considered.

3 Method

Our first aim is to identify and describe the open source software editors’ business models. Our second objective is to relate these different business models to the choice of standards.

3.1 Quantitative Analysis of Open Source Editors’ Profiles

In order to propose a taxonomy, we list nearly 200 free software, designated by the specialized sites as the most used by IT developers[1]. We use Teece’s framework (2010) to address the business model concept. We thus consider the organizational and financial architectures as the two dimensions of a business model. We define organizational architecture by 1) the legal status of the entity that has the software and, 2) its organizational form that is more or less open and structured, described by terminology bazaar or cathedral (Raymond, 1998). The financial architecture, for its part, is described by the two components of 1) the intellectual property policy (IP) and, 2) the sources of income.

Table 1. Business model framework

Business Model (Teece, 2010)	Organizational architecture	Legal status
		Organizational form
	Financial architecture	Intellectual property right
		Revenue streams

Additional variables are considered illustrative variables: the nature of the software defined by the code’s status (open or closed) that allows to qualify the innovation process, governance of the organization bringing the software according to the typology of Demil & Lecocq (2006) inspired by the work of Williamson (1996) and finally the organization of the ecosystem within the meaning of Lakhani and Boudreau (2009) (market or community). To

[1] www.open-source-guide.com

enrich our database, we also completed the information on the category of the software, the official website, the used license(s), year of creation of the software, the number of lines of code, the number of contributors to the software, the number of downloads of the software and the programming language used.

The study aims to define profiles of publishers. To do this, we use the TwoStep Cluster method available in SPSS. This method allows to reveal natural groupings in large databases. We exclude the classification method in dynamic clusters because this method requires to enter *a priori* a defined number of groups. The selected method imposes certain constraints and assumptions: independence of variables and sorting biases.

3.2 The Choice of Standards According to the BM

We postulate that the programming language can be considered as a *de facto* dominant technical standard when this one is widely and largely used in reference to the installed user base notion (Farrell & Saloner, 1986). A standard is considered as emerging when this one is "hype" and growing in use. This indication is given by the language rank in the annual classification of the Tiobe Index[2]. Tiobe Index is a reference in software programming. Every year, this company calculate the ranking of more than 240 programming languages[3].

Many acceptations of standards can be seen in literature. De Vries et al. (2008) consider the program in a hole as a standard (internet browser). Some others consider the MS Office Word as a standard while it is a program. In our study, the language used to develop the program is considered as a standard element. Like the XML programming language was studied as a standard because of its official standardization (Vion, Diaz, Dudouet, & Graz, 2013), we focus on this variable but in the *de facto* standardization sphere (Foray, 2002). Moreover, the language is a more stable component of a technological solution than a solution itself. As Krechmer (2006) signals, a software or a technological solution is difficult to consider as a standard because of its permanent enhancement. Yet the stability is a key characteristic of a standard.

In order to address our research question, we focus on the relation between technical standard that is represented by the programming language and business models of the open source editors.

3.2.1 Cases Selection and Data Collection

The first stage of our work was to select a category of programs. In order to have recent and innovative software, we selected the Cloud Computing category in a list of 300 software established by the Open Source Guide[4]. We obtained a sample of 5 competing solutions. For each one, we identified the original editor and its open source business model according to the framework of our quantitative analysis. For each program, we reported according to 1) the year of the first commit (can be considered as a year of market introduction); 2) the programming languages up to 3, classified by the % of using in the program[5]; 3) the rank of the main development language, one year before the first commit.

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[2] http://www.tiobe.com/tiobe_index?page=index

[3] For details on the calculation model, see: http://www.tiobe.com/tiobe_index?page=programminglanguages_definition

[4] www.open-source-guide.com

[5] www.openhub.net

This letter information is key because we consider that the choice of the programming language is made at the beginning of the project. Usually, this occurs about one year before core developers decide to open source the project because there must be a “minimum viable product” that can show the essential features of the software.

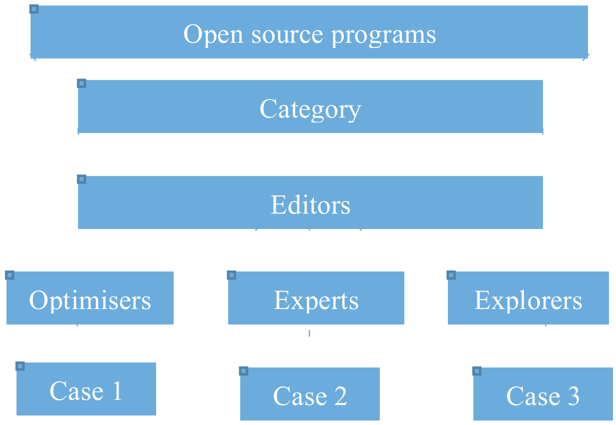

Figure 2. Cases selection process

4 Results

Our results are twofold. We firstly set up a publishers’ business model taxonomy in open source sector regarding to the openness strategy. Then we highlight the technical standard choice in each model according to its popularity and openness.

4.1 Open Source Business Models

4.1.1 Natural Open Source Clusters Results

Chi-square test results confirm variables dependency[6]. Thus, the nature of the company behind the software has an influence on its licensing policy (var. IPR), its organizational model (var. orga form) but also its appropriation of value (var. source of income). The business model represents a comprehensive approach where the choices adopted for each parameter affect the entire model. Despite this variables dependency, the analysis by the TwoStep Cluster method is allowed because it is "strong enough to violations of the independence assumptions."[7]

Our first result shows that it is possible to identify three types of groups among our 200 software and the quality of our clusters is correct (Figure 4).

The weight of each of the four variables in determining the clusters is shown in the figure 5. We observe that the groups were strongly influenced by the variable "income" and the variables "IP". Variables of "legal status" and "organizational form" were less decisive. This was due in large part to the largest number of responses available to the variable "source of income" (7 types of responses against 3 and 4 for the other three).

[6] Asymptotic significance less than 0.05
[7] Extract from the SPSS Help section

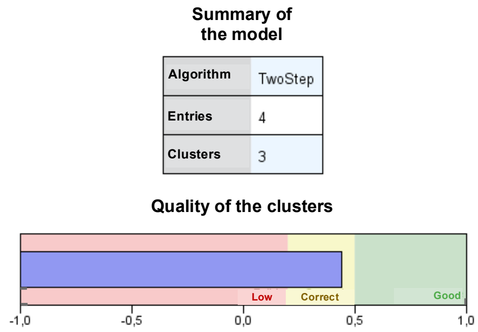

Figure 3. Quality and summery of the 1st TwoStep Cluster

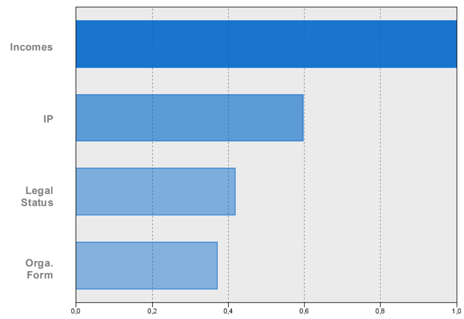

Figure 4. Weight of variables

Table 2. Clusters' distribution

Cluster	N	% of combined	% of total
1	61	30.7%	30.7%
2	66	33.2%	33.2%
3	72	36.2%	36.2%
Combined	199	100%	100%
Total	199		100%

The cluster size is homogeneous and the size ratio of the largest cluster size on the smallest cluster is less than 3 (1.18).

SPSS offers us three groups defined as follows:

The first group includes private publishing companies whose intellectual property policy is mixed: open license combined with a closed *entreprise* license. Their main source of income comes from the *entreprise* license rents combined with other possible sources that are service and sponsorship. The organization model of their various information flows is that of bazaar model (existence of a community) as well as that of cathedral model (flows inside the firm).

The second group also consists of private publishers but also communities which, unlike the first group, adopted exclusively an open IP policy (GPL and other open source licenses) with a business strategy focused on service and sponsorship. The organization is hybrid with a strong dominance of the bazaar structure.

The third group is made up of communities, foundations and associations. This group has a completely open IP policy. Its revenues come from the donations and sponsorship. Information flows are in the form of the bazaar. We note that this group is more heterogeneous than the previous two where private publishers were highly dominant. In this group, we have three types of actors that are represented at more than 70% each. This group deserves more detailed analysis.

To refine our analysis and have a number of clusters with good representativeness (previously, it was "correct"), we perform a second analysis of our sample by forcing this time ranking to 4 groups.

With this new operation, we improve the quality of our clusters. The distribution between the clusters is also satisfactory as the largest cluster ratio on the smallest cluster is always less than 3 (1.85).

Figure 5. Quality and summary of the 2^{nd} TwoStep Cluster

Table 3. Clusters' distribution

Cluster	N	% of combined	% of total
1	61	30,7%	30,7%
2	60	30,2%	30,2%
3	33	16,6%	16,6%
4	45	22,6%	22,6%
Combined	199	100,0%	100,0%
Total	199		100,0%

In the new treatment, the distribution is the same as in the first test and we can identify four types of groups. The first group is the same as identified during the first treatment. The second is also very close to the second cluster identified during the first treatment. Regarding the third group, this one was split in two, which confirms the need to a better refinement.

So, the new third group is mainly represented by the foundations, and to a lesser extent by some communities. The license policy adopted by this group is only "open source". Sources of revenue are mainly due to the couple "donations and sponsorship."

Group four is, for its part, made up of communities and associations organized in a bazaar model. Unlike the group 3, the license used is exclusively the "GPL" and the sources of income are strongly related to pure donations.

4.1.2 The Taxonomy's Description

The descriptive analysis of 200 software allows us to identify four types of business models where three are specific to software developed in open source innovation. We propose to call them by separating the business model of engagement, that is specific to pure free software, from the other three business models that we call exploration business model, expertise *and optimization.* The taxonomy is presented in the following table. We can notice at the left the Teece's two business model dimensions. In the last three lines, we can find complementary information that permits clarifying the models. Moreover, the four business models are classified by 1) their commercial and market interest; 2) their openness strategy.

Table 4. Open source editors' business models: open strategy vs. market concerns

Market inscription

Openness strategy

		OPTIMIZATION	EXPERTISE	EXPLORATION	ENGAGEMENT
Organizational architecture	Legal status	Private firm	Private firm	Foundation	Non-profit organisation
	Organizational form	Hybrid (Cathedral & Bazaar)	Hybrid to Bazar	Bazaar	Bazaar
Financial architecture	Intellectual property right	Copyright + Copyleft	Controlled copyleft	Controlled copyleft	Full copyleft
	Revenue streams	Rents + Services + Sponsoring	Services	Donations + Sponsoring	Dons
Product	Status of software	Hybrid (open & closed)	Open	Open	Open
Firm	Governance model	Hierarchical + Network	Hierarchical + Bazar	Network	Bazaar
Ecosystem	Ecosystem organization	Market + Communal	Market + Communal	Market + Communal	Communal

Exploration business model: open to innovate

This business model concerns mainly editors that are registered as foundations. Projects that they develop are supported by a strong network of partners that are involved financially but also in terms of availability of resources. The organizational form is that of bazaar: in one hand, the community is free to contribute to the source code of the software without selective entry; on the other hand, a certain internal control is established for official partners' contributions in order to ensure the quality and stability of the software. This one is offered under an open source license. The income of the foundation comes from various donations but above all, from an elaborate sponsorship program: the partners engage with amounts that can be very high (for the OpenStack project, for example, the Platinum Partnership is $ 500 000 / year and the provision of two full-time developers dedicated to the project of the foundation). This business model is specific to editors that develop highly innovative technological projects. Their objective is the technological development and research. They are born in favour of projects that could be described as exploratory and are keen to maintain their objectives out of the market constraints. In order to keep a great freedom for their research project, founders rely often on a legal structure that is in charge of finding revenues, hire experts, communicate effectively and invest in infrastructure that maintain a qualitative research environment. Finally, the governance of these explorers is structured in a network with relationships based primarily on exchange and reciprocal incentives (Demil & Lecocq, 2006). These incentives are of average intensity: the best developers can be hired by the partners, invited to events or become ambassadors; professional partners benefit from a valuation system that lead to certification as "expert" and from a better visibility on the project's website.

Expertise business model: open to create value

This business model concerns editors that are registered as private companies. They rely on their software development competences and not on the proprietary rents that protection of this one can bring. In this model, the software is open sourced thanks to a copyleft licence. All the community can participate to its development. However, this participation is framed with road maps and steering committees, and the organization is considered as hybrid bazaar. Unlike the model of exploration, developments should remain close to the market needs and not only driven by the technological research. The main incomes of these editors come from the services added to the software. That is why software should be close to consumers' need to promote additional services. Also, the quality of contributions is a key factor for the editors' reputation and notoriety. Again, because their main incomes are linked to the diffusion of the software and because this diffusion is conditioned by the quality of the code and features, the community has to create true value with its contribution. Regarding the governance, editors can deploy a hierarchical model within their organization and a bazaar model with their community. The expertise business model is highly adapted for those who wants to fulfil with open source innovation without giving up the economic concerns.

Optimization business model: open to make business

This model refers to what practitioners call "open core editors". It concerns private organizations that propose their software under two formulas: an open and community based version which is the core of the software; and a closed and paying version that includes all the features developed internally. The first version is proposed under an open source licence which is compatible with commercial concerns (controlled copyleft), and the second improved version is proposed under an *enterprise* licence (copyright type). The letter version relies heavily on the community version but is maintained only by the employees of the private organization in a "cathedral" way. The free of the first version is allowed by the rents that the second one can bring. This two speed model attract more and more editors and is at the cross of proprietary and open models. Editors that adopt this business model benefit both the community emulation and creativity, and the secure of a more controlled version that can be sold. In addition to proprietary rents, there is an important part of these editors' incomes that is linked to the services they can provide.

The open source business models described above show that there are specific logics in open worlds. So, as BM innovation can be very different according to the openness and closure of the field and because the standard, like we see previously, is a key determinant of openness and closure in the markets, we made the hypothesis that there is a correlation between technical standards choices and business models' decisions.

4.2 Standards' Choices in Open Source Business Models

We consider the choice of the programming languages. They are qualified according to their statute of dominant, emergent or nascent standard.

4.2.1 Balancing Between Openness and Popularity

The table 5 below summarizes our selection of the five case studies from the Cloud Computing category, and the business models corresponding. We will then identify the programming languages that are used for each case to define the software.

Table 5. Software and editors' business model in Cloud Computing category

Software	Editor	Characteristics	BM
OpenStack	OpenStack Foundation	**Organizational Architecture** Legal Status: Foundation Organizational form: Bazar **Financial Architecture** IP: Controlled copyleft Income sources: sponsorship and donations	Explorer
OpenNebula	OpenNebula Systems	**Organizational Architecture** Legal Status: Private firm Organizational form: Hybrid **Financial Architecture** IP: Controlled copyleft Income sources: services	Expert
CloudStack	Apache Foundation	**Organizational Architecture** Legal Status: Foundation Organizational form: Bazar **Financial Architecture** IP: Controlled copyleft Income sources: sponsorship and donations	Explorer
Eucalyptus	Hawlett Packard	**Organizational Architecture** Legal Status: Private firm Organizational form: Hybrid **Financial Architecture** IP: Hybrid Income sources: rents, services	Optimiser
Nimbus	University of Chicago	**Organizational Architecture** Legal Status: University Organizational form: Bazar **Financial Architecture** IP: Controlled copyleft Income sources: sponsorship and donations	Explorer

In this list we excluded CloudStack because it is supported by the Apache Foundation that supports many other programs. Thus, it was not relevant to observe strategic implications of technical standard choice of only one program among tens of others that constitute the Apache Foundation activity. We also excluded Nimbus edited by the University of Chicago because it represents an academic exploration that imply specific considerations.

Our final sample is made up of OpenStack, edited by the OpenStack Foundation; OpenNebula, edited by OpenNebula Systems and Eucalyptus, edited by Hawlett Packard.

Table 6. Case studies and their programming languages

Program	Editor	BM	Year of creation	Lang. 1	Lang. 2	Lang.3	Rank Y-1 Lang. 1	% of user base
OpenStack	OpenStack Foundation	Explorer	2006	Python (77 %)	XML (13 %)	Otheres (10 %)	7	2,506%
OpenNebula	OpenNebula Systems	Expert	2008	C++ (48 %)	Ruby (36 %)	Shell (11 %)	3	10,425%
Eucalyptus	Hawlett Packard	Optimiser	2009	Java (54 %)	C (14 %)	Groovy (6 %)	1	20,849%

One year before the first commit of OpenStack in 2005, Python, the main programming language of this software had 2,506% of the user base and thus, was ranked in the 7^{th} place of the top programming classification. For its part, C++, the language adopted by OpenNebula was in 3^{rd} position with 10,425% of the user base. Finally, in 2008, one year before the first commit of Eucalyptus, Java, its main programming language was ranked as number one in the programming languages classification with 20,849% of the user base.

Once we observed the classification of the languages used by our three editors, which represents the popularity of the technical standard, we will observe their openness. For each one, we graduate it according to West's (2004) definition of openness.

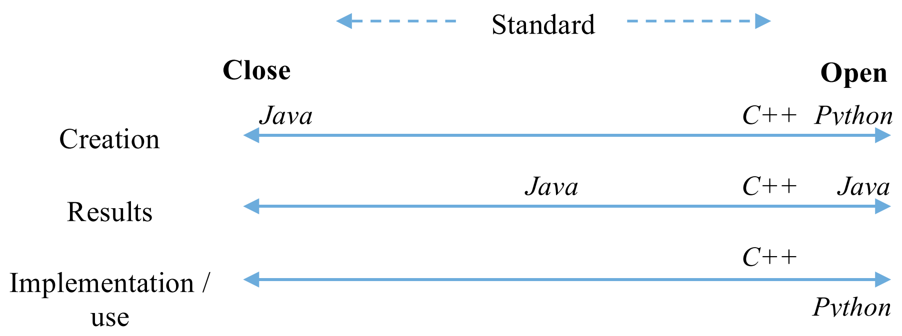

Figure 6. Programming language openness analyse through West's graduation

Java is one of the most popular programming language created by Sun Microsystems that was bought by Oracle in 2009. According to West's graduation, Java is not a full open standard. It is a dominant standard because it is widely used (according to the Java website, there is more than 9 billion developers using it all around the world), but it can't be considered as totally open because it is owned and maintained by a specific vendor which is Oracle. The process of creation is furthermore closed to a restricted membership and conducted by Oracle. The results of the language creation and updates are publicly available and downloadable whereas some elements of the language specifications are patented. The implementation and the use are fully opened without any selection.

C++ is for its part one of the oldest programming language. Its first version was published in 1983. The C++ was standardised by the ISO in 1998. Since that, three updates were published and the last was published in 2014. The next standard is planned for 2017. This standard can be considered as fully open because from the beginning, it was open sourced by its creator, Bjarne Stroustrup. The C++ language belongs to nobody. The standard creation process is also completely open and all the drafts are proposed to the community through the GitHub platform[8]. Access to results and implementation are free too. The C++ community is supported by a non profit foundation that has a mission of promoting and supporting financially the standardization work.

Python was created in 1990 and publicly open sourced for its first version in 1991. It is supported by the Python Foundation that was created for managing the trademark and the financial supports of the community. Python is a technical *de facto* standard. The specifications are documented, collegially decided through the PEP program (Python Enhancement Proposal) and freely available for implementation to everyone.

[8] GitHub is the main collaborative platform for open source projects: https://github.com/cplusplus/draft

4.2.2 Technical Standards and Open Source Business Models: A Positive Relation

While observing the popularity of the languages and their openness, regarding to the projects that they allow to develop, we can grab strategic considerations of editors: there is a correlation between the technical standard popularity and the market orientation of the business model, and at the same time, the openness of the standard and the openness of the editor's strategy.

Table 7. Correlation between technical standards and business models

Project Editor	Eucalyptus *Hawlett Packard*	OpenNebula *OpenNubula Systems*	OpenStack *OpenStack Foundation*
Technical standard choice	Java	C++	Python
Standard popularity	Dominant	Emergent	Nascent
Standard openness			
Business Model strategy	Optimiser	Expert	Explorer
BM market orientation			
BM openness strategy			

Dominant standard to make business, the case of optimisers:

As the main objective of editors of this category is to optimise their investments in relying both on community advantages and proprietary potential rents, they naturally tend to use large dominant technical standards to develop their programs. This strategic decision allows them to count on a wider and larger contribution of the community. Because the standard is dominant, they can expect to interest a larger base of developers that knows and uses this standard and thus, can contribute to the improvement of the solution. The community version is an important driver for this business model because it is a pool of inspiration for the proprietary version and because it legitimates the services offered around the software.

Some literature focused on the negative effects of the standardization on creativity and team effectiveness (David & Rothwell, 1996; Thompson, 1965). In our case, editors count on the standard to aggregate and motivate contribution and thus, innovation and creativity for their products. In line with conclusions of Rosenberg (1976), the presence of a standard is able to reduce uncertainty and grant a widespread diffusion of a technology. In our case, an open standard that is dominant ensures not only the diffusion of a technology but moreover the expansion of innovation and thus, the expansion of the business. The technical standard choice is a key component of the optimisers' business model construction because it impacts the two essential concerns of the concept: the value creation (the standard allows the aggregation of a community), and the value appropriation (if the software attract massive contributions, this will allow a more precise development of the proprietary version that will fit with the real needs of the market and thus, grant revenues for the editor).

Emergent standard to create value, the case of experts:

Developing a specific expertise on a dominant open standard is difficult. There are many firms that can do it and the market is quickly saturated. This situation led to intensive competition and the falling price of the services that can be proposed. In contrary, choosing to built a software and thus a service offer on an emergent technical open standard, that is not yet dominant but in a process of growing adoption, can procure interesting opportunities. Be among the first to propose solutions relying on this kind of standards and to be recognized for that is a great manner to ensure revenues from sophisticated services. The notoriety is here crucial. The capacity of the editor to aggregate a qualitative community around its software using an emergent standard is a positive technical signal to the market. It positions the firms as an expert in its field.

The experts' business model is closely and positively linked to the emergent standard adoption. In open worlds, the notoriety is a competitive advantage that can be built on technical skills of a firm. Thus, technical choices are components of this competitive advantage. To be capable of managing and developing a community around a solution that uses emergent open standard is a key component of the expertise building.

Nascent technology to innovate, the case of explorers:

The explorers' business model is the ideal type of open source business model. It is totally communal, without any commercial versions and it focuses on technological excellence. Financial and market concerns are committed to organisation (often a foundation) that acts as a sponsor of the software. This edition model allows founders to concentrate on exploration aspects and to have a very close relation with a more restricted but highly qualified community. The objective of this model is not to make big profits but just to have enough revenues to continue exploration. Thus, the language of software development adopted can be totally new and nascent. It is even better if the technical standard is practiced by few insiders because the value of their contribution is even more precious and valuable. For editors of this kind, exploring new features is the main driver and often, for doing so, new technical tools are needed. But because we are in open source sector, these new tools need to be also well documented and freely available for allowing the community contribution. That is why the core strategy of explorers are closely related to their technical standard choices.

5 Discussion

5.1 Implications for Research

The present study intends to analyse the standard's role in open innovation (Chesbrough, 2003). We could have expected that open innovation requires the implementation of open standards. However we showed that this relation depends on business concerns.

First, open innovation is more accurately observed in open worlds like open source software sector. Open source innovation represents an emblematic and specific case of open innovation (Chesbrough et al., 2006; Pénin, 2011). Specifically, it supposes new business strategies (Chesbrough & Rosenbloom, 2002). In this contribution, we explored the nature of standards implemented by the editors according to the business models. This relation has never been observed before. Our first contribution enriches the literature on the business model by proposing a new taxonomy of open source software editors. Our findings reveal three business orientations that oscillate between two continuums: the openness strategy vs. the market inscription. Openness strategy is used for the purpose of value creation, which represents the first component of a business model (Chesbrough & Rosenbloom, 2002;

Mansfield & Fourie, 2004). Market inscription is motivated by the more or less value capture interest, which represents the second major business model component. Editors using open innovation to create value have to balance between the attraction of a potentially unlimited source of contributions and the need of being profitable that suggests a certain closure. We characterize these three editors' types as optimiser, expert and explorer.

Second, we contribute to the literature on standards by highlighting the business implications of the standard choice in open innovation processes. Our study shows that strategic orientations of a firm in terms of value creation and value capture are tightly related to the nature of the technical standard chosen in the beginning of the project, i.e. in the supply phase (Anderson & Tushman, 1990; Clark, 1985; Tassey, 2000; Weiss & Birnbaum, 1989). The results of our exploratory case study confirm that in open worlds like open source software, the choice of technical standard is related to the choice of BM. To do so, we had to distinguish between technological and technical standards and to analyse open standards in their complexity: 1) regarding to the degree of openness and 2) to the market success of these technical standards. Relying on the percentage of market share, we differentiated dominant, emergent and nascent standards. We showed that the more the editors' concerns are market oriented, the more the standard is dominant. And in the same time, the more the editors' interest for openness and value creation is high, the more the standard is open - according to West's graduation. Finally, open standards are preferably chosen even when this openness is not as pure as it could be expected, which is mostly the case in open source innovation.

5.2 Implications for practitioners

We pointed out the importance of the standard's choice in open source software industry. Open environment is complex. It is regulated through specific rules. Management requires a delicate balance between the compliance with the openness duty and the need of profitable structure. In this context, the role of the supply side standard is determinant. We showed how the two dimensions of openness and market success of a technical standard had to be arbitrated since the early beginning of the software development. Later, as some scholars showed (Cusumano, Mylonadis, & Rosenbloom, 1992b; de Vries et al., 2008), the BM itself impacts the standardization strategy of the firm on the demand side (what kind of sponsoring, standardization in committees or consortiums etc.).

5.3 Limitations and future research directions

Our exploratory research opens up new research paths because there are many aspects to observe and to complete in order to better understand the link between standards, openness and strategic firms' choices. First of all, our cases are exclusively observed in open source sector while it would be important to introduce in the study cases that belong to proprietary software sector. Even if our optimiser case includes a proprietary dimension, it is not a pure proprietary player. Moreover, it is necessary to observe the role of standards in other open fields like cultural sector, automotive or pharmaceutical industries where more and more open projects are experienced. Further in depth cases studies are necessary to understand the causal relation between the use of standards and strategic orientations of the firms' following an open strategy. In the present paper we observe a relation between the technical standard choices and the business model construction without addressing the exact role of the standard in the construction of the business model. Is it a determent or just a contingent context? Do managers really and practically select the technical standard they want to use in investigating its business consequences or is it just a natural orientation? These questions are in line with Astley and Van de Van's (1983) ontological approach of the standards when they suspect that the most difficult dimension to address in standardization literature is that of deterministic –

voluntaristic behaviour. We suggested that the standard's choice is related to the business model and our first results bring support to this hypothesis. Further researches on standard's adoption choice would enrich this contribution. One new perspective could be showing how adopters take their decisions in the cases that require a strategic arbitration.

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Chinese Standardization System: Past History, Current Status, Future Changes

Luke Hung-yu Chuang

University of Washington
hyjuang@uw.edu

Abstract: *China is now the second largest economy in the world and plays a significant role in global commerce. After China opened its doors and issued market reform, Chinese high-tech enterprises faced major challenges in technology standards in international trade, as most of them were patent-poor and standard-receivers. The Chinese government therefore established its indigenous innovation industry policy to encourage the development of China-developed standards and intellectual property. With the largest consumer base in the global market, China's indigenous standards significantly influence the world ecomomy. However, current standardization research has little emphasis on this emerging economy in the East. As a result, this paper attempts to systematically discuss the Chinese standardization system from China's past history, its current status, and prospects for the future and potential changes. The first part of the paper offers an overview of the history of standardization development in China, explaining how the Chinese government established the standardization system under a planned economy and later used the system to protect its domestic economy. The second part analyzes the role of the Chinese government in the system, focusing on the government's development of standards through administration and research. The final part discusses China's ongoing reform of the standardization system. The paper discusses the government's plan to simplify its existing system and to recruit the private sector in standard-setting. China's government seeks to resolve current problems on overlapping, low-quality standards and revise these standards to reflect and meet the needs of China's transforming economy.*

1 Background

China's experience after two decades of reform and engagement with the international economy post-1980s led the government to understand that its sole reliance on patent-poor "standards taking" put China at a considerable economic disadvantage. China's DVD player industry serves as a clear example of this experience. In the late 1990s, DVDs had an established standard developed by an alliance of Japanese, American and European corporations. With a fully developed technology, Chinese corporations had little room to alter the standard for DVDs or provide alternatives to foreign mandated patents and their associated royalties. Thus by 2002, China's domestic DVD player manufacturers were required to pay the foreign 3C and 6C alliances $26.20 USD for patent royalties whenever manufacturing and exporting each DVD player. A DVD player was sold around $90 USD at the time, so the patent royalties accounted for 20-30% of the whole manufacture cost. With these associated patent royalty costs, profit margins for Chinese DVD player manufacturers fell to one dollar per unit in 2004. As a result, many of these Chinese enterprises stopped exporting or manufacturing DVD players, some even shut down.

The Chinese government recognized that control over standards and their incorporated patents granted the holder considerable market power. In 2006, the government commenced its fifteen-year *Medium- to Long-Term Plan for Scientific and Technological Development*, followed by the introduction of many new implementation policies. These rules became China's "indigenous innovation" industrial policy. The Chinese government used standardization as a tool to achieve its indigenous innovation goals. One of the primary objectives of the indigenous innovation was to develop products that incorporated China-created intellectual property ("IP") and followed China-developed standards. These China-developed standards are based on different technologies in contrast to technology standards developed through the Western standard-setting processes. For instance, China has its domestically-developed TD-SCDMA and TD-LTE telecommunication standards, as well as the WAPI wireless standard. Through setting these Chinese standards, the government aimed to help Chinese domestic enterprises get rid of standard essential patents ("SEPs") and their associated royalty fees. The government did not allow the free market to simply identify the best technology solution. Instead, China aimed to reverse its position from a standard-taker to a standard-setter.

Whether China legitimately developed its indigenous standards remains an issue of controversy. Many foreign corporations and governments allege that these China-developed standards violate the Technical Barriers to Trade ("TBT") Agreement under the World Trade Organization ("WTO"). However, despite these criticisms, no one can deny China's rapid growth and transformation in the last few decades. Based on GDP, China is now the second largest economy in the world, and plays an important role in the world economy. These China-developed standards have substantilly impacted global commerce. Therefore, it is necessary and important to understand China's standardization system.

The paper will discuss China's standardization system sequentially. The discussion begins with the history of Chinese standardization development and will then examine the role of the Chinese government in standardization development today. The final section dicusses ongoing changes in the standardization system.

2 Chinese Standardization History

China is a nation that boasts of centuries of legacy and tradition. In its 5000-year history, China achieved some outstanding developments in standardization. However, most of these developments in standardization focused on the traditional technology field, such as measurement methods and rail transportation. After the Industrial Revolution, standardization and its correlated activities became an important issue in the West. Whereas China, still under the rule of the Qing Dynasty during the 19th century, began to decline. Many of its territories were gradually colonized by predominantly Western nations. After the fall of the Qing Empire, China experienced civil war during the first half of the 20th century. Under these circumstances, China's developments in standardization remained fairly stagnant. It was not until the establishment of the PRC government in 1949 did China commence its progressive movement in standardization policies and activities. This study examines China's standardization policies post-1949.

Generally, China's history of standardization may be separated into two periods: from 1949 to the mid-1980s, and from the mid-1980s to the present. The first period occurred after the PRC government was established, but just before the government started to transform its system of planned economy. During this time, the Chinese standardization system followed the Soviet Union and Eastern European country models. The PRC government established, administrated, and enforced standards. The second period of standardization in China commenced when the PRC government began transforming its planned economy to a socialist market economy with Chinese characteristics. China then joined the WTO in 2001. China did not change much during its fundamental period of standardization, although it attempted to make some changes during this transformational period. The following section discusses in detail each of periods.

2.1 Phase 1: 1949-Mid-1980s

During this period, the Chinese economic system was a centrally-planned economy. The PRC central government controlled and regulated production, distribution, and prices. The central government also established and enforced standards. When the government issued these standards, these standards then became technical regulations. These standards were therefore compulsory, and the government and enterprises were required to comply with the standards.

2.1.1 1949-1966: Forming a Standardization Administration System

The first period of this stage of standardization development was from 1949 to 1966, which began after the establishment of the PRC government and ended before the Cultural Revolution. After its state of disarray in the 19th century, China sought to recover its economy. After the new PRC was established, the government commenced standardization development. In its *First Five-year Plan*, the PRC government regarded the standardization development as an important technical policy in its economic development. The Plan instructed departments to establish standards for design, and requested the competent authorities in the central government to establish product standards. Since then, the government has emphasized organizing standardization activities and establishing standardization regulations and institutions.

Influenced by the Soviet Union's model of a planned economy, the Chinese standardization system during this period bore the following primary characteristics: "centralized leadership and administration, governing by administration orders, and compulsory effects for whole standards." With these centralized characteristics, the PRC government formed a preliminary model for future standard administration systems. Given this model, the central government led the standardization administration; the competent authorities under State Council and local governments took charge of standardization activities; and research institutes established standards. Under the planned economy, the central government monopolized the purchasing and marketing of private enterprises' products. Relevant industrial authorities in State Council bore semblances to large state-owned enterprises. It was therefore mandatory to follow all levels and types of standards, including national standards, ministerial standards, local standards, and enterprise standards at the time.

2.1.2 1966-1976: Suspending Standardization Development

China experienced internal turmoil during the Cultural Revolution from 1966 to 1976. During this time period, the PRC government shut down, which caused serious negative consequences on China's nascent economy. Due to a dysfunctional government, China's standardization development ceased to progress during this period. For example, only 400 national standards were issued by the government from 1966 to 1976. After the Cultural Revolution though, the number of standards issued increased radically each year.

2.1.3 1976-Mid-1980s: Modernization, Government Reorganization

After the Cultural Revolution, the PRC government restarted its economic development with a focus on modernization and internationalization. Standardization development during this time period progressed significantly. The State General Bureau of Standardization ("SGBS") and China Association for Standardization ("CAS"), two important Chinese standardization institutions, were both established in 1978. The SGBS was the predecessor of the current Standard Administration of China ("SAC").

In addition, China increased its interactions with developed countries and participation in international organizations within the standardization field. During the 1980s, China signed cooperation agreements with many national standardization organizations in Germany, France, U.S., etc. Influenced by these countries and their organizations, in 1979, China started to form Technical Committees ("TCs") for standardization in different technological fields. Even now, TCs remain the primary institutions that establish or revise technology standards in China. (The following section on "the Role of the Chinese Government" will provide a detailed discussion regarding TCs and the SAC.)

Despite its reform and open policy, China at the time still possessed strong characteristics of a planned economy. During its government reorganization in 1982, China improved and solidified its centralized standardization system, where the central government led the standardization development and the competent authorities and local governments took on individual responsibilities. China established Departments of Standards in relevant ministries, commissions, and bureaus under the State Council to assume responsibility and oversight. China also established 19 Standardization Research Institutes in 18 of the ministries and bureaus mentioned above. Furthermore, China established the Bureau of Standards and Standardization Information Agency in 29 local governments. At the end of 1984, there were 2,000 people working in the Department of Standards and Standardization Research Institutes, as well as over 8,000 people working in the Bureaus of Standards and Standardization Information Agency.

2.2 Phase 2: Mid 1980s-Present

Since the 1980s, the PRC government started to transform its planned economy toward a market-based economy. In the marketization process, China also learned from developed countries methods to reform its standardization system. Passing the *Standardization Law* in 1988, the government gave up its practice of universal compulsory standards in the planned economy, and instead recognized the status of voluntary standards in its standards system. The *Standardization Law* also permits and authorizes Chinese enterprises to develop standards.

Despite including voluntary standards in its system and recruiting enterprises as standard-setting bodies, the PRC government nonetheless did not change its standardization infrastructure much. The establishment of voluntary standards still required approval and resources from the government. The PRC government continued to play a significant role in leading and controlling standardization activities.

2.2.1 Mid 1980s-Early 2000: Passing the Standardization Law, Joining the WTO

China passed its *Standardization Law* in 1988, and then its *Regulation for the Implementation of the Standardization Law* in 1990. The legislation was a milestone in China's standardization development. In passing the legislation, the Chinese government attempted to transform its standardization governance from an administrative protocol to a legislative process. Under the new laws, the standards in China transformed into serving for-trade and business purposes; in the past, these standards were merely focused on a manufacturing purpose. In addition, the standards changed from compulsory standards to voluntary ones.

Besides the transformation and change at the time, the *Standardization Law* continues to govern current standardization systems in China. Under the current system, standards in China can be categorized into four different categories: national standards, industrial standards, local standards, and enterprise standards. The former three are established by the central and local governments, whereas enterprise standards are established by the private sector. However, China's standards are prioritized according to its level of priority. For example, the central government can establish new national standards to replace industrial standards. The new national standard then invalidates the old industrial standard. Likewise, new national or industrial standards can be established to replace and invalidate local standards. Therefore, the central government's standards surpass other standards and are prioritized accordingly.

Instead of simply being comprised of purely compulsory standards, the new Chinese standardization system under the *Standardization Law* was composed of a mixture of voluntary and compulsory standards. Compulsory standards are those requested to enforce by laws and administrative rules, and those involving issues of human health, personal security, and property safety. Otherwise, all other standards are voluntary standards. The following Table 1 demonstrates the percentage of compulsory and voluntary Chinese standards existing in 2013. In light of Table 1, it seems reasonable to conclude that voluntary standards account for the majority of Chinese standards. However, the Chinese government still has the power to approve proposals for voluntary standards and the power to decide funding to support the development of these voluntary standards. To some extent, these standards can be construed as not entirely voluntary, because the government still retains an influential role in standardization development; the private sector is not the primary standard-setting body.

Table 1: Cumulative Amount of Compulsory and Voluntary Standards in China (2013)

	National Standards		Industrial Standards		Local Standards		Total
	Compulsory	Voluntary	Compulsory	Voluntary	Compulsory	Voluntary	
Amount	3,712	26,642	3,465	34,297	3,437	24,221	95,774
Percentage	12.23%	87.77%	9.18%	90.82%	12.43%	87.57%	

Source: China National Institute of Standardization ("CNIS"), p.36, 50, 55 (2014)

In the 1990s, China focused on bringing its economy more in line with international practice and joining the WTO. These focus impacted the development of Chinese standards. It became an important Chinese standardization policy at the time to adopt both international standards and advanced overseas standards. In addition, when China prepared to join the WTO, the issue of Chinese standards and standardization development received widespread attention, catching the attention of the WTO and its members in particular. In its negotiations to join the WTO, the Chinese government reached 13 promises on the issue of standards and standardization. These promises included signing the TBT Agreement and corresponding with its requirements. Although China ultimately joined the WTO in 2001, China was confronted with the SEP problem, particularly SEPs as non-tariff barriers ("NTB") in international trade. The Chinese government thereafter proposed its indigenous innovation industrial policy to change its standard-taker position.

2.2.2 Early 2000-Present: Formulating National Standardization Strategy

After joining the WTO, China recognized that technology standards and their incorporated IP had a serious impact on Chinese domestic economic development. The government therefore considered standardization and IP as national-level issues, and then proposed a national strategy on these issues. In the *Tenth Five-year Plan* period from 2001 to 2005, the Ministry of Science and Technology ("MOST") invested 200 million RMB (about $31.5 million USD) to sponsor two significant projects concerning standardization. The projects were titled "*Study on the Strategy of China's Technical Standards Development*" and "*Study on the Construction of a National System of Technical Standards*." These projects conducted both a large-scale and intensive analysis of the standardization development process and strategies utilized by developed countries, developing countries, and standard-setting organizations ("SSOs"). In their conclusion, the projects suggested that China needed to increase indigenous technologies in standards, to improve regulations concerning standardization, to participate in international standard-setting competition, and to move toward a voluntary standardization mode.

In the beginning of the *Eleventh Five-year Plan* period (i.e. 2006), MOST issued the *National Eleventh Five-year Scientific and Technological Development Program*, and the SAC formulated the *Outline of Eleventh Five-year Plan on the Development of Standardization*. Of significant influence on the scientific and technological development of that period, the MOST's Program proposed to fully implement the national standardization strategy to safeguard the scientific and technological developments in China. Meanwhile, the SAC's Outline guided China to enhance its overall quality in standardization, highlight key areas for standardization, and decide research tasks for standardization. More importantly, together with the *Medium- to Long-Term Plan for Scientific and Technological Development* from 2006 to 2020, the SAC's Outline specified several key principles that the government should follow when implementing indigenous innovations. Generally speaking, China's strategy is to use technology standards as a tool for indigenous innovation. Dominating in the standard-setting process, the Chinese government would rather adopt its independently developed technology in setting its domestic national or industrial standards than rely on foreign technology. For China, the goal of its national standardization strategy or indigenous innovation policy was to reduce its technological dependence on foreign companies.

Since 2000, the Chinese government has significantly invested and researched ways to formulate its national standardization strategy. The government thereafter issued many relevant guidelines and policies, which aimed to transform China's position from standard taker, to standard co-setter and lead-setter. Now, the fundamental principle of the Chinese national standardization strategy is to let the "government lead, enterprises direct, and the market guide." This strategy includes: (1) transitioning to a voluntary standards system fitting market economy; (2) improving market adaptability of Chinese national and industrial standards; (3) harmonizing relations between standards, technological innovation, IP protection, and industry upgrades; (4) adopting international standards with efficiency, joining international competition on selection, and supporting Chinese indigenous technology as international standards. Regardless of whether this happens now or in the future, this strategy significantly impacts China's technological and scientific development.

3 The Role of the Chinese Government

The Chinese government plays a significant role in its standardization development. The government administrates standardization, as well as formulates and research standards. The following sections will discuss these three perspectives in sequence.

3.1 Administrating Standardization

The Chinese government applies a fairly hierarchical and organized structure in managing its standardization activities. Generally speaking, the central government leads standardization development; however, the competent authorities and local governments have taken these responsibilities on an individual basis.

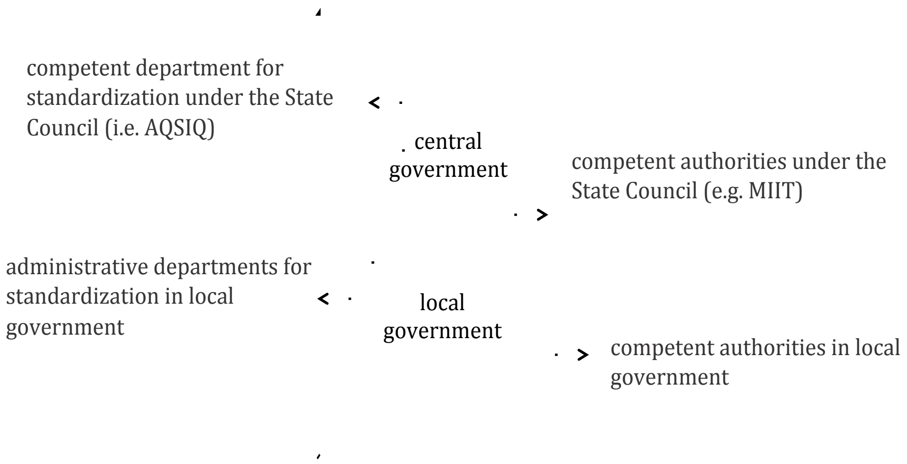

Figure 1: Chinese Standardization Administration System
Source: Compiled by the author

As shown in the Figure 1, the top of the pyramid indicates the department in charge of standardization under the State Council. This department exercises unified leadership over the standardization work throughout the country. In the middle of the pyramid, the figure displays the competent authorities under State Council, and these authorities are in charge of the standardization work in their own departments or industries. The bottom of the pyramid shows a similar structure for the local government, which includes provinces, autonomous regions, and municipalities directly under the central government. In their respective administrative regions, the administrative departments for standardization exercise unified leadership over standardization work; the local authorities are then responsible for the standardization work in their own departments and industries.

At the top of the hierarchical structure is the General Administration of Quality Supervision, Inspection and Quarantine ("AQSIQ"). Administered by the AQSIQ, the Standard Administration of China ("SAC") is authorized by the State Council to exercise unified administration and oversee the administrative responsibilities for standardization tasks in China. The SAC was established in 2001, its predecessor being the SGBS and State Administration of Standardization ("SAS"). The SAC's tasks and duties include: developing national standards, organizing to implement the State's standardization regulations, organizing to formulate national standardization programs, guiding and coordinating lower institutes in their standardization work, contacting relevant international standardization organizations, etc.

At the middle of the hierarchy are competent authorities under the State Council, such as the Ministry of Industry and Information Technology ("MIIT"), Ministry of Environmental Protection ("MEP"), Ministry of Health of ("MoH"), etc. These different ministries are in charge of the standardization work in their own industries, so they may promote, establish, and adopt standards for the respective industry fields they are responsible for. For example, MIIT is highly active in the information and communication technology ("ICT") industry. Many of China's indigenous technological standards, such as TD-SCDMA and WAPI standards, have been developed under MIIT's auspices. In addition to developing industrial standards, these ministries are responsible for formulating standardization programs in accordance with their respective responsibilities, undertaking State-assigned tasks in drafting national standards, guiding local government in its standardization work, etc.

At the bottom of the hierarchy is the local government, which is composed of administrative departments for standardization and the competent authorities in each administrative region.

The primary task of the local government is to develop local standards, implement standardization regulations of the State or superior competent authorities, and formulate standardization programs in local government.

Table 2 demonstrates the cumulative number of Chinese national standards, industrial standards, and local standards during the period of 2005-2009.

Table 2: Cumulative Amount of Chinese Standards (2005-2009)

Year	National Standards		Industrial Standards		Local standards		Total
	Amount	Percentage	Amount	Percentage	Amount	Percentage	
2005	20,688	26.58%	40,070	51.48%	17,079	21.94%	77,837
2006	21,410	29.28%	33,552	45.89%	18,155	24.83%	73,117
2007	21,569	30.74%	36,589	52.15%	12,003	17.11%	70,161
2008	22,931	29.87%	39,686	51.7%	14,142	18.43%	76,759
2009	23,657	28.92%	42,765	52.29%	15,360	18.78%	81,782

Source: KUANG BING, p.156-157, CNIS, p.16 (2010).

3.2 Formulating Standards

The current Chinese standardization administration system is composed of a vertical hierarchy at different levels and a horizontal array of complementary institutions. As a whole, the SAC under the AQSIQ develops national standards; different ministries under the State Council develop their own respective industrial standards; local governments develop local standards. However, these government institutions are to administrate and coordinate the standardization activities. These institutions are the final decision makers for the finalized drafted standards. The draft and preparation of the standards did take place in the institutes' TCs or Subordinate Technical Committees ("STCs").

In China, each of the government institutions mentioned above has its own TCs and STCs to help these government institutions formulate standards specific to the technological field. The Chinese government established the TCs in 1979. As time went on, the government recognized the importance of the TCs or STCs, so the committees' total amount and covered technological field increased. In the end of 2013, there are in total 521 national TCs and 715 STCs, which mainly help to formulate national standards. There are also over 572 local TCs, which help to formulate local standards.

The TCs and STCs are professional organizations consisting of authoritative technology experts. Their primary tasks are to draft technology standards and examine technology solutions, which can help formulate, revise, and maintain technology standards. The Chinese government encourages the (S)TCs to have a diverse composition in order to obtain different ideas and opinions. The committees consist of representatives from government agencies, research institutes, testing institutes, state-owned enterprises ("SOEs"), private enterprises, university, industry association, consumers, etc. In other words, the committees have great experience and knowledge in manufacturing, research, usage, marketing, and testing. Every (S)TC also has its own subordinate secretariat. The secretariat then takes care of the daily routine work for the (S)TC's operation.

Table 3: Secretariat Undertaker in National TCs: 2008 and 2013 Comparison

Undertaker	Year	
	2008	2013
Research institute	66.45 %	63%

Testing institute	6.08 %	5%
Enterprises	7.88 %	10%
Association, alliance	8.78 %	17%
Ministry, commission	9.23 %	
University, publisher, etc.	1.58 %	5%

Source: CNIS, p.64(2014), CNIS, p.26(2010)

The Chinese government attempts to have diverse composition in (S)TCs to obtain various sources of technological ideas. However, research institutes have far more innovation capacity than private sector in the current Chinese economy. In addition, Chinese society tends to consider standards as public rights and public property. Research institutes funded by the government are considered to be for the public interest. Thus, research institutes play influential roles in (S)TCs, as well as significantly impacting how to formulate and revise standards in China. As shown in the Table 3, research institutes are in charge of over 60% of the secretariat of whole national TCs in both 2008 and 2013. Even though private enterprises and industry associations are growing more important in the Chinese economy, they merely account for less than 10% of the secretariat. Despite minor changes from 2008 to 2013, private sector has not taken a leading role in standardization development in China.

3.3 Researching Standardization

In addition to managing standardization and formulating new standards, the Chinese government conducted in-depth research on standardization. The government has long established different standardization research institutes at the national, industrial, and local levels. The hierarchy is similar with the infrastructure mentioned in Figure 1. Located at the top, the SAC has a national standardization research institute CNIS, which focuses on issues pertaining to national standards. In the middle, the competent authorities under State Council may establish its own industrial standardization research institute, which focuses on the issue of industrial standards. At the bottom, local governments also have their own local standardization research institutes, which focus on issues pertaining to local standards. These different levels of standardization research institutes serve as “think tanks” for the central and local governments. Their primary tasks include undertaking fundamental standardization research, as well as providing standard information.

4 Chinese Standardization Reform

The Chinese government has established its own standardization administration system as early as 1988 when the *Standardization Law* was first enacted. China’s standardization system was developed nearly 30 years ago when China was still under the regime of a planned economy and was just starting to transform into a market economy. China remains in this transitional phase into a market economy today. In particular, the Chinese economy became interconnected with the global economy after joining the WTO. Given this change, China’s traditional system of standardization faced the challenge of meeting the requirements of social and economic development. In response, the government began enforcing the *Strengthening Standardization Reform* in 2015. The purpose of this Reform was to improve the Chinese standardization system, increasing the competitiveness and adaptability of Chinese-developed standards.

4.1 Problem of Existing System

4.1.1 Overlapping and Conflicting Standards

Prior to the introduction of the recent *Strengthening Standardization Reform*, China's standardization system encountered a number of problems. The first problem existing at the time was overlapping and conflicting Chinese standards. To manage its standardization activities, China established a hybrid administrative and institutional system composed of a vertical hierarchy of four levels and a horizontal array of complementary institutions. However, this system often lacked coordination between its institutes, and their standards, many of which overlapped and conflicted with each other. For example, as of this writing, there are approximately 2,000 national, industrial, and local standards, all of which have the same name. This dilemma demonstrates that certain technology or processes have formed into standards but at different levels. When producing some products, enterprises may incorporate the at-issue technology or utilize the process with varying standards. Without coordination among the hierarchical structure, some national standards overlapped with industrial or local standards, and vice versa. Because different ministries and local governments developed their standards independently, many standards were redundant at times. These overlapping standards imposed multiple requirements on enterprises to meet, which created an undue burden on these entities to comply with these standards. The lack of coordination wasted government resources, especially in setting and enforcing these standards.

In addition, some of these overlapping standards imposed conflicting technological requirements on enterprises. This problem arose especially when the technology is used in multiple technology fields. Because ministries held different positions in the technological field, the problem of conflicting industrial standards was further exacerbated. Given these conflicting requirements, enterprises struggled to adopt the standards, and consequently, the government also faced hardship in enforcing these standards. The conflicting standards presented by government bodies that did not communicate proved harmful to consumers and deterred industry development in China. The overlapping and conflicting standards harmed the credibility of the standards themselves and the government that created and enforced them. They also impaired the public welfare of consumers and society.

4.1.2 Deficient Market Participation

In China, the governments developed national, industrial, and local standards. These efforts reflected a largely planned economy thinking that the government should actively and heavily direct standard development, rather than rely on the market and private sector. However, 70% of China's effective standards were related to general products and services, and not those involving human health and security issue. Most of the existing Chinese standards are voluntary standards, rather than compulsory standards. These voluntary standards are ultimately applied in the market and adopted by enterprises, which results in a market and enterprise-led standard-setting. Today, many Chinese standards cannot be effectively enforced, because they did not originate from the market and its market players.

In addition, the research institutes funded by the Chinese government still play significant roles in (S)TCs and have a great impact on formulating standards. Unfortunately, both government officials and scientists in the research institutes have a limited understanding of the market and enterprise needs. As a result, very often the government-developed standards or (S)TCs-proposed technology solutions depart from the needs of the market. Even though the government recognized this problem and attempted to increase diversity in (S)TCs, it is questionable whether the process is transparent, fair, and open. Current government-led standardization systems continue to lack ideas and innovation from the market and private sector. Neither the market nor the private sector can effectively supervise the government's standardization development. Continuing to bear characteristics of a traditional planned-economy, China's standardization system is incompatible with a nation that is transitioning into a market economy.

When China transformed its economy to a market economy and connected with the global economy, this transformation of the economy upgraded Chinese industry and increased the innovation capacity of domestic enterprises. Despite the strides made in obtaining innovative technology and recognizing the significance of standards, private enterprises and their formed industry associations still played a limited role in standard-setting in China. Industry associations were not eligible to formulate standards for the association's and its participants' use, which is widely-used in the world. Because of this, market-led and bottom-up standards rarely exist under the Chinese regime. The private sector is prohibited from release its innovative ideas and the government cannot access this innovative technology, dampening development in the Chinese industry.

4.1.3 Low quality and coverage

The Chinese government has developed more than 100,000 national, industrial, and local standards as of 2015. The number of existing standards is indicative of the government's efforts in developing these standards. However, it is questionable whether the government's effort and investment resulted in any returns. Many of the Chinese standards update at such slow speeds that the old standards cannot meet the requirements of a rapidly-changing industry. Many of these standards are also low in quality and cannot support an upgrade in the Chinese industry. Because its standards are usually low-quality, China only dominates 0.5% of the entire international standards in 2015. In addition, Chinese standardization development is not universal; it merely focuses on some specific industrial areas. As a result, China still lacks standards in some technological areas, such as agriculture, service, e-commerce, and business logistics.

4.2 Ongoing Change

Recognizing the problems mentioned above, the Chinese government implemented the *Strengthening Standardization Reform* in 2015 to improve its current standardization system. The government reconsidered its governing role in standardization development in its transforming economy. In the Reform, the government released some authority and responsibilities to the private sector in standard-setting, thereby obtaining more innovation from the market and developing market-oriented standards. Meanwhile, with its remaining authority, the government became stricter in standardization governance than in the past. The Reform granted the private sector more authority to develop standards; the government can then save its administrative resources and focus on the governance of limited standards. The objective of the Reform is to bifurcate China' standardization model: one that is government-led and one that is private sector-led. The former track emphasized maintaining fundamentality; the latter emphasized enhancing competitiveness. These two tracks were designed to collaborate and coordinate standard-setting activities to improve the current Chinese standardization system. China ultimately hopes that future standardization development is led by the government, motivated by the market, participated by society, and pushed by both the public and private sectors.

In light of the Reform, the government restructured its standardization administration system, as seen in Table 4. Generally speaking, government-led standards changed from six categories to four categories. The competent authorities and local governments no longer issued new compulsory industrial and local standards.

Table 4: Chinese Standardization System: Before and After Reform

Characteristic	Item	Before Reform		After Reform	
		Compulsory	Voluntary	Compulsory	Voluntary
Government lead	National standard	X	X	X	X
	Industrial standard	X	X		(X)
	Local standard	X	X		X
Private sector set	Enterprise standard		X		X
	Association standard				X

Source: Compiled by the author

On the other hand, private-sector setting standards increased from one category to two categories. Industry associations may now develop "association standards" in China. Moreover, when these industry associations become much more competent and mature in the future, the Chinese government may release to associations the authority and responsibility of developing voluntary industrial standards. The following section discuss in detail the primary changes in the Reform.

4.2.1 Simplifying Compulsory Standards

In light of the Reform, China will merely keep compulsory national standards in its standardization system and will no longer develop compulsory industrial and local standards in the future. However as of 2013, China has already accumulated 3,712 compulsory national standards, 3,465 compulsory industrial standards, and 3,337 compulsory local standards. The Chinese government has already begun to review and clean up these existing compulsory standards. After the review process, the government will invalidate the obsolete standards. In addition, the government plans to strictly restrict compulsory standards only to specific areas, such as human health, human life, property safety, national security, and environmental safety. Standards not in these areas would move to the category of voluntary standards. As for the compulsory standards that remain that are neither invalidated nor removed, the government plans to merge these compulsory standards at all three levels of government into only one at the national level.

Regarding the future of standardization administration, the State Council will have the authority to approve and issue these standards; the SAC will be responsible for project approval and numbering of the standards; the competent authorities under the State Council will take charge of proposing and drafting the standards, requesting public comment, examining technology, enforcing, and supervising.

4.2.2 Creating Association Standards

The Reform included industry associations as one of the standard-setting bodies in the current Chinese standardization system. Prior to the Reform, only the government and enterprises were eligible to set up standards; industry associations had a very limited function in standard-setting. After China opened and reformed its economy, Chinese private sector were getting innovative and active in the market economy. The Reform legalized industry associations to develop "association standards" so that the Chinese standardization system could obtain more ideas originating from the market. These association standards are for voluntary use in the market, so the market ultimately decides the success or failure of these standards.

In addition, industry associations may develop and issue association standards independently. The association standards do not need to get prior approval from the government. As a result, the government plays a limited and passive role in developing association standards. The government will merely provide the *Guidelines regarding Developing Association Standards* and *Code of Good Practices for Standardization*. Otherwise, the government will mostly leave the market to decide the development of association standards, and will intervene only when necessary.

4.2.3 Optimize Voluntary Standards

In this Reform, it appears that the infrastructure of government-led voluntary standards did not change. The SAC, different ministries, and local governments continued to develop voluntary national, industrial, and local standards. However, the Chinese government attempted to reduce the amount and scale of their voluntary standards. The government is now reviewing and refining the voluntary standards at three levels. In the future, the government will transition to only developing voluntary standards with the public interest in mind. Moreover, the government also plans to leave the market and industry associations to themselves in hopes that they will develop voluntary industrial standards.

4.3 Future Influence

The creation of association standards marks a milestone for the Chinese standardization system. Today, as the Chinese economy grows more connected with the global economy, Chinese industry and society recognize the benefits and advantages of innovative technology. However, foreign enterprises own most of advanced technology, whereas most Chinese corporations or research institutes do not own such competitive technology. The corporations and institutes can hardly develop new technology and correlating standards independently; rather, the development will be based on the advanced technology of foreign corporations.

One primary example of such development can be seen in China's TD-SCDMA standard in 3G telecommunication technology. The Chinese government invested nearly the maximum permitted for financial support to develop the indigenous standard. The government also afforded a variety of administrative and technical support. Despite these efforts and investment, the standard ultimately was not very successful. This is partly because the Chinese domestic telecommunication industry lacks sufficient innovation capacity to develop the indigenous standard by itself. The standardization development was mostly led by the Chinese government, research institutes, and SOEs, which possess limited knowledge of the market. On the other hand, the Chinese government did not allow foreign enterprieses to participate significantly in standard-setting meetings, and also does not grant many protections for IP. The restriction and limitations of the IP market deterred foreign corporations from contributing their innovative technology to the Chinese standard. For example, in the past when foreign corporations joined the standard-setting meeting, they were only permitted to attend the meeting but lacked voting rights or the ability to propose new standard specifications to discuss.

Having enforced the indigenous innovation policy for the last decade, China now recognizes the difficulty of isolating itself from global commerce and competition. In the forthcoming association standards, the government will play a limited role in standardization development. Whereas the government formerly organized and officiated standard-setting meetings, today, the government passively participates as an invitee to the meeting instead. Without the government's intervention, foreign corporations are allowed to increase their participation in standard-setting activities, and domestic corporations are permitted to direct the standardization process.

China held several pilot projects on association standards, and many of these projects have been successful. Foreign and domestic corporations propose or develop their technology with the intent for future incorporation into association standards, which can then be adopted by association members. The potential to incorporate and adopt the technology entices more corporations to join and develop the association standards. Because of this, standard-setting activities for Chinese association standards are growing more similar to the standard-setting activities of the West. More importantly, this trend also demonstrates that some Chinese domestic corporations are competitive in the innovation market. Thus, this development is a milestone not only for the Chinese standardization system, but also for China's transforming economy.

The creation of association standards could potentially help China obtain greater knowledge of the global market and upgrade its industry. However, the government needs to offer a transparent and predictable legal environment that protects these standard-setting activities. Foreign investors are primarily concerned about IP protections. China's most competitive corporations also raise the same concerns. For China to improve its standardization system, it is not enough for the government to simply reduce its involvement in the standard-setting process and permitting increased foreign corporations' participation. The government's commitment to protecting technology innovation will directly impact the future of China's technology market. The stronger the protections, the more likely the government can incentivize competitive domestic and foreign corporations to invest in China's market.

5 Conclusion

This paper summarized China's standardization system. The discussion section provided historical background under which the system was established and later evolved to fit societal and economic development in China. The paper then discussed the primary standard-setting institutions under the Chinese regime. The final section analyzed the ongoing reform of the country's existing standardization system. The Chinese government recognizes problems within its system and is working to improve the system to adapt to the Chinese economy's transformation. The Chinese standardization system is currently moving towards a market-driven system. As of this writing, it remains uncertain whether the ongoing Reform will work well and whether the system will ultimately reach a final stage. However, the only certainty is that the Chinese standardization system will continue to evolve just as the current Chinese economy is evolving.

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The Interplay Between European Competition Law and Standardisation

*Barry Connolly**

Flynn O'Driscoll Business Lawyers, IE

BarryConnolly@fod.ie

Abstract: *Whilst it is undoubtable that standardisation can have a positive effect on technological development, there are many different concerns relating to standardisation operating in a competitive market. Competition law is designed to ensure the effective and efficient operation of markets whilst targeting behaviour that is ultimately damaging to the consumers. Two of the main weapons available to European authorities in tackling competition law issues in the European Union (EU) are Articles 101 and 102. However, both the operation of both these pieces of competition law regulation can impact upon the standardisation process. This article will evaluate the interplay between these specific pieces of competition law and standardisation. An analysis of how technological standardisation has been affected by EU competition law and in particular how intellectual property rights (IPRs) are dealt with in the standardisation process will be detailed, including how authorities deal with the misuse of those IPRs in such a way that can ultimately damage the standardisation process.*

1 Article 101 – Anti-competitive Agreements

The process by which private commercial entities may go about setting standards (through mutual agreements or otherwise), whether they be inside or outside some type of industry fora or consortia, can lead to a situation where such conduct can amount to collusion. Such agreements fall within the remit of Article 101 of the Treaty on the Functioning of the EU (TFEU).

While the aims of Article 101 are numerous, little consensus exists on its exact main objectives. Historically it can be seen as simply a tool for securing the internal market against the actions of private undertakings (and that of states, when they act in an economic or commercial capacity in the market).[1] Whereas state actions that impede the internal market are primarily dealt with under the free movement provisions, private actions require separate treatment. The aim of increasing efficiency[2] on the market is generally the most often cited benefit. By increasing efficiency, competition can maximise consumer welfare through the optimal allocation of resources. By precluding agreements that interfere with the operation of the market, competition will not be affected therefore protecting consumers and especially smaller firms from oligopolistic or monopolistic dominance.[3] This can be particularly relevant for the topic at hand as it is small entities that can often be most affected by the lock-in[4] of a particular standard. Of course it should be remembered that this is not to suggest that

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* BA, LLB, LLM, Solicitor, European Trade Mark and Designs Attorney.

[1] Wesseling, *The Modernisation of EC Antitrust Law* (2000, Oxford) 48.

[2] Craig and De Búrca, *EU Law: Text, Cases and Materials* (2008, Oxford) 950.

[3] *Ibid* at 951.

[4] Liebowitz and Margolis, "Path dependence, lock-in and history" (1995) 11(1) *Journal of Law, Economics and Organization* 205.

competition law should protect fatally less economically efficient undertakings (or standards) from the operation of a competitive market.

Article 101 is an extremely powerful piece of antitrust legislation, automatically voiding any agreement that would fall within its parameters.[5] Through recent regulations,[6] it no longer requires the European Commission (the Commission) to declare permissible, self-assessed agreements that fall under the Article's provisions.[7]

Where potential competitors, who operate on the same level of the market and come together to implement some type of standard, consideration will need to be given to Article 101. These agreements are referred to as horizontal agreements.[8] Article 101 is aimed at eliminating any agreements between these competitors that may;

> "affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the internal market"[9]

Strictly applying this definition[10] would mean that certain standardisation agreements may foul of Article 101. The treaty also specifically refers to some specific types of anti-competitive agreements, including those that "limit or control production, markets, technical development, or investment"[11] or "make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts."[12] This last type of behaviour would occur in the case of standard setting organisations, where contracts may only be concluded where parties agree to limitations, such as Fair, Reasonable and Non-Discriminatory (FRAND) requirements or even just abiding by a Standard Setting Organisation's (SSO) rules that would not necessarily relate to the market operation of the standard. Specifically the Commission has identified specific circumstances where the standard-setting process can restrict competition, through a reduction in price competition, and influencing control over the market in terms of production, innovation and technological development.[13] Not to mention that a locked-in[14] standard may in itself simply form a barrier to entry onto the market.[15] This will be even more of a problem when IPRs are involved as it may grant the IPR owners the opportunity to exercise control over an aspect fundamental to the operation of the market. Furthermore lock-in itself could create a dis-incentive to innovate in the technology as once a dominant standard exists on the market all innovation tends to

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[5] Article 101 (2), TFEU. [2008] OJ C 115/47.

[6] Regulation 17/62.

[7] Regulation 1/2003, Article 1. See also; Whish and Sufrin, "Community Competition Law: Notification and Exemption – Goodbye to All That" in Hayton (ed.) *Law's Future(s): British Legal Developments in the 21st Century* (Oxford, 2000).

[8] See generally: Kovacic, "Identification and Proof of Horizontal Agreements under the Antitrust Laws" (1993) 38 *Antitrust Bulletin* 5.

[9] Article 101 (1), TFEU. [2008] OJ C 115/47.

[10] Problems with exactly defining agreements under these laws can be difficult, See; Kovacic, "Antitrust Policy and Horizontal Collusion in the 21st Century" (1997) 9 *Loy. Consumer L. Rep* 97.

[11] Article 101 (1)(b), TFEU. [2008] OJ C 115/47.

[12] Article 101 (1)(e), TFEU. [2008] OJ C 115/47.

[13] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 264.

[14] Liebowitz and Margolis, *loc. cit.*

[15] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 266.

focus[16] on improvements to that standardised technology whilst possibly disregarding alternative technological avenues.[17]

These rules do not just apply to private SSOs. The officially recognised SSOs[18] would fall under Article 101's definition of an undertaking or an association of undertakings and therefore their agreements can fall under Article 101. In fact there has been recent ECJ case law involving Article 101 and agreements concerning CEN. In *EMC Development AB v European Commission*,[19] the court examined a complaint by a cement manufacturer that the standard set by CEN, with the co-operation of large European cement manufacturers infringed Article 101 (and Article 102, which prohibits the abuse of a dominant position). In that case, EMC Development AB:- (i) had objected to the standard adopted by CEN in the classification of Portland cement; and (ii) suggested that this breached Article 101 as the standard was essentially developed by a cartel (of large European Portland cement producers) wishing to create a barrier to the European cement market. In its judgment, the court specifically referred to previous Commission guidelines on Article 101, stating that the agreements of such SSOs, as publicly authorised bodies are subject to the obligation of member states in preserving undistorted competition in the Union.[20] In that case the court even saw fit to examine some of the private operations of CEN and investigate the transparency of its standardisation process. However it should be noted that this case involved the interaction between CEN, a public SSO and a private undertaking, Cembureau (the European Cement Association).[21] It is this involvement from active competitors on the market where problems usually occur. With the exception of concern over ETSI's policies in the last 10 years, the official SSOs rarely encounter competition law issues, especially during times when standardisation has been mandated by the Commission. As the Commission also plays an observer role[22] to the official SSOs, it will be extremely unlikely that anti-competitive agreements may ensue. In fact the Commission's guidelines on horizontal agreements specify that they do not apply to "the preparation and production of technical standards as part of the execution of public powers."[23] This is primarily aimed at avoiding conflict with any standardisation that a member state (or EU institution) may initiate in implementing legislation. However it should be remembered that such standardisation, whether it takes place within the relevant national ministerial department, or delegated to the national standardisation authority, must still be notified to the Commission under the technical standards directive.[24]

Regardless of the involvement of the large European standardisation entities, it is however well recognised that some agreements can be vital to advancing technological development and therefore should be permitted.[25] Such agreements *should* immediately fall under the exemption to Article 101, contained in Article 101(3). This states that Article 101(1) may not apply as long as the agreement:

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[16] Meyer and Lehnerd, "Modular Platforms and Innovation Strategy" in Katz (ed.) *The Human Side of Managing Technological Innovation* (2004, Oxford) 691.
[17] Dosi, "Technological paradigms and technological trajectories" (1982) 11 *Research Policy* 147, 153.
[18] As recognised under Directive 98/34/EC.
[19] Case T-432/05, *EMC Development AB v European Commission* (2010) Unreported.
[20] European Commission, *Guidelines on the applicability of Article 81 of the EC Treaty to horizontal cooperation agreements*, 2001/C 3/02, Para 162.
[21] Case T-432/05, *EMC Development AB v European Commission* (2010) Unreported, para9-11.
[22] CEN and CENELEC, *Guide 12 – The concept of Affiliation with CEN and CENELEC* (2008, Brussels).
[23] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 258.
[24] Directive 98/34/EC.
[25] Jorde and Teece, "Rule of Reason Analysis of Horizontal Arrangements: Agreements Designed to Advance Innovation and Commercialize Technology" (1993) 61 *Antitrust L.J.* 579.

> "contributes to improving the production or distribution of goods or to promoting technical or economic progress, while allowing consumers a fair share of the resulting benefit, and which does not:(a) impose on the undertakings concerned restrictions which are not indispensable to the attainment of these objectives;(b) afford such undertakings the possibility of eliminating competition in respect of a substantial part of the products in question."

Although there is some debate[26] as to the boundaries of this exception, particularly as to whether the required benefits must be purely economical or extend to generally improving European industry,[27] it would seem that standardisation would fall under either requirement. One of the central aims of standards is to improve economic efficiency. Furthermore, the Commission's willingness to work closely with the SSOs demonstrates that they acknowledge the importance of standardisation to Europe's global competitiveness.

2 The Horizontal Agreements Guidelines

In late 2010, the Commission adopted a new set of Guidelines on the applicability of Article 101 to horizontal agreements. The aim of the guidelines is to provide an analysis of some of the most common form of horizontal agreements, such as, *inter alia*, R&D, purchasing, commercialisation and standardisation agreements, so that companies concerned can be guaranteed that they do not infringe European competition law.[28] These are a revision[29] of a previous set of guidelines published in 2002.[30] These guidelines came into force on 1st January 2011.[31]

The improvement to the standardisation chapter was one of the most significant overhauls in the new set of guidelines.[32] The older guidelines were criticised for their lack of precision in relation the procedures that SSOs should adopt.[33] The Commission's approach to this problem was to clearly set out requirements for the procedures of standard-setting, irrespective of whether or not it takes place inside a SSO. The Commission requires that the process be unrestricted; transparent; there be no obligation to comply with the standard; and FRAND terms apply if necessary.[34] Specifically with regards to transparency in the procedure, the Commission has proven to be very much in favour of as open a process as possible.

For example, in 2009, the Commission opened proceedings against the IACS (International Association of Classification Societies), an umbrella organisation of ship classification societies. The Commission was concerned in particular with the process by which organisations can apply to become members to the society. In response, the IACS promised to abide by certain commitments,[35] which the Commission later made legally binding.[36] These

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[26] Chalmers et al, *European Union Law* (2006, Cambridge) 1006.
[27] Whish, *Competition Law* (2003, 5th Edition, London) 151.
[28] Anon, "Revised rules on horizontal co-operation agreements adopted" (2011) 75 *European Newsletter* 1.
[29] Batchelor and Jenkins, "A limited improvement." (2011) 10(2) *Competition Law Insight* 9.
[30] European Commission, *Guidelines on the applicability of Article 81 of the EC Treaty to horizontal cooperation agreements*, 2001/C 3/02.
[31] *Ibid*.
[32] Sattler, "Standardisation under EU competition rules – the Commission's new horizontal guidelines" (2011) 32(7) *European Competition Law Review* 343.
[33] *Ibid* at 346.
[34] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 280.
[35] European Commission, Notice published pursuant to Article 27(4) of Council Regulation (EC) No 1/2003 in Case 39.416 — Ship classification.
[36] European Commission, *Antitrust: Commission paves way for more competition in ship classification market by making IACS' commitments legally binding* IP/09/1513.

commitments promised to implement a transparent membership process.[37] It is possible that this case had an influence on the guidelines as the Commission specifically refers to the need for there to be "unrestricted participation"[38] in SSOs guaranteed through objective and non-discriminatory procedures in relation to voting powers.

The Commission is explicit in its requirements for a clear IPR disclosure policy. The IPR policy of SSOs can often be the source of disputes, as seen in the ETSI and Rambus cases. In 1993, ETSI (the European Telecommunications Standards Institute) proposed a new IPR Policy (and Undertaking). This new policy was unique in that, whilst including the usual language in relation to requiring licenses on FRAND terms, the policy essentially adopted a licensing by default scheme. Participants would be obliged grant licences, based on monetary consideration, with such royalties notified in advance. A limited right to withhold the granting of such licenses was granted to participants. It should be noted that this occurred shortly after the disputes arose in relation to the GSM standard where Motorola refused to commit to certain licences (instead seeking specific cross-licensing arrangements into the European market). Despite the issues that arose in the GSM standard, ETSI's new IPR Policy (and Undertaking), with its restriction on the freedom to negotiate contracts and the limited right to withhold caused considerable consternation amongst its larger IPR holders. In the face of this debate, ETSI abandoned the proposed policy wording in 1994.

Rambus concerned the classic dispute that can arise in relation to IPR disclosure in the standard setting process. The standard related to memory technology, standardised by JEDEC (Joint Electron Device Engineering Council). In that case Rambus was accused of not disclosing standard essential patents during the standardisation process. A string of US case law followed, which left it uncertain as to whether Rambus' conduct breached US law. The (European) Commission also issued objections to Rambus' behaviour, but these were ultimately settled when Rambus complied with certain binding commitments.

In light of this background, the Commission now requires that any IPR policy would need to oblige participants to provide irrevocable commitments,[39] in writing, to license any essential IPR, on FRAND terms. These must be given even when no royalties are being charged, so as to ensure no discrimination takes place between participants. The use of the word "irrevocable" is evidence of the importance that the Commission attributes to this requirement. This is much stronger than the language that many of the private SSOs currently use.[40]

Despite the subjective nature of defining FRAND terms, the Commission attempts to provide some clarity on its requirements. Specifically in relation to cost, the Commission concedes that a mere cost-based approach may not be flexible enough to fit all situations.[41] It suggests that a comparison can be made between the patent royalties charged, *ex ante*, (before the industry is locked in) and *ex post*, (after lock-in).[42] The possible use of independent expert

[37] Derenne, "Binding commitments of standard making organisation" (2010) 1(2) *Journal of European Competition Law & Practice* 162.
[38] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 281.
[39] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 285.
[40] BDA, Amended & Restated Bylaws of Blu-ray Disc Association. The author notes there are however certain SSOs that do include relatively strong language. See. E.g. Oasis (Organization for the Advancement of Structured Information Standards) Intellectual Property Rights (IPR) Policy, Effective 15th Oct 2014.
[41] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 289.
[42] *Ibid*.

assessment of the value of a participant's IPR portfolio is also mooted by the guidelines.[43] The Commission is also concerned that these valuation methods must also ensure consistency.[44] It is obvious that the Commission is painfully aware of the difficulties involved in royalty assessment and would seem to be doing its best not to ignore the issue.

With regard to disclosure of IPRs the Commission adopts a "good faith disclosure" approach.[45] This requires participants take "reasonable endeavours"[46] to identify whether or not the standard is developing in such a way that will ultimately infringe the IPRs of the participant. An argument can be made that this is a rather weak requirement to be placed on participants. Although it equates to the disclosure policy of some of the official SSOs[47] it may not be enough to tackle a future Rambus-style dispute.

Even from a general analysis of the wording of the guidelines, paragraph 285, which lays out the Commission's approved good faith disclosure policy, it is clear that a cautious tone has been taken so as not to enforce an overly onerous disclosure requirement. One reason for this is probably due to cost considerations.[48] For large corporations, who may have extensive IPRs, it may be extremely costly, to that particular participant, to cross-reference their IPR portfolio with that of the IPRs being incorporated into the standard. It has already been noted that some technological standards, particularly in ICT can incorporate thousands of IPRs.[49]

Furthermore disclosure is to be made before the relevant committee adopts the standard. Legal teams may simply not have the opportunity to go through the entire IPR portfolio and find patents that may need to be disclosed within this time-frame. Of course it may be argued that if a company faithfully upholds its FRAND commitments subsequent to discovering a patent, essential to the standard but not disclosed at the technical committee, then no problem should occur. The technical committee may not have had an opportunity to decide with the knowledge that there were undisclosed patents, but FRAND will limit any potential economic ramifications.

However participants may not always wish to agree to FRAND commitments. Sometimes a participant will see their IPR as worth much more than FRAND will get for them. From the IPR holder's perspective, FRAND may not take all factors into account. It may not fully appreciate the amount of R&D that has gone into certain IPRs. This type of concern is exacerbated to a much greater extent in private SSOs than the public SSOs where R&D may not play as vital an element, particularly in non-technological areas. Furthermore, the guidelines only require a FRAND requirement, when a participant wishes "to have their IPR included in the standard."[50] Where a participant in the SSO fails to monitor their IPR portfolio, certain IPR may be included in the standard, over which the IPR holder was never willing to provide a FRAND commitment.

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[43] *Ibid* at 290.
[44] Case 395/87, *Ministère Public v Jean-Louis Tournier* [1989] ECR 2521, para 38; Joined Cases 110/88, 241/88 and 242/88, *Francois Lucazeau v SACEM* [1989] ECR 2811, para 33.
[45] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 286.
[46] *Ibid*.
[47] CEN/CENELEC, CEN-CENELEC Guidelines for Implementation of the Common IPR Policy (Patents and other statutory intellectual property rights based on inventions) (2010, Brussels).
[48] Ohana, Hansen and Shah, "Disclosure and negotiation of licensing term prior to adoption industry standards: preventing another patent ambush?" (2003) 24(12) *European Competition Law Review* 644.
[49] Prins, "The Need to Standardise in an EDI Environment: Balancing the Legal Conditions and Implications" in Carr and Williams, (eds.), *Computers and the Law* (1994, Oxford) 43.
[50] European Commission, *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01, Para 285.

Therefore, what should happen in these situations? To put the potential problem simply; the requirement of good faith disclosure could nevertheless lead to IPR being incorporated into the standard, where a company has not been thorough in checking the patents it holds. What happens if the standard is adopted and a subsequent patent ambush occurs? It is an exact replica of Rambus, only there were no bad intentions on the part of the licensor.

One possible method of resolving this potential lacuna in the guidelines would be to resort back to some of the more traditional legal solutions available in equity. This would include redefining what exactly "good faith disclosure" would entail. Under this solution it is suggested that if an entity fails to disclose a patent, *in good faith*, which is subsequently adopted into the standard, then the IPR owner should be estopped from enforcing any of those rights whatsoever i.e. they should be precluded (estopped) from relying on their own failure to disclose. Whilst it is acknowledged that this may result in harsh outcomes for the IPR holder, it is asserted that it can be attributed to the IPR holder's own failure to adequately check its IPR portfolio. Furthermore if the perceived value of this IPR is so much that they would consider an ambush, how were they not aware of it from the start?

It should also be acknowledged that a company may have a vast range of patent rights, all of which they may not be fully aware of during the standard-setting process, however the costs associated with properly assessing the extent of their IPR portfolio will be much lower than the cost to the industry of a patent ambush. Surely the legal fees for a comprehensive review of a company's IPR portfolio cannot be compared against the legal fees involved in a single patent ambush case against just one other SSO participant.[51] In just one of the cases that Rambus initiated, attorney fees for one party amounted to over $7 million.[52]

The potential threat of this would also act as an incentive for the IPR holder to not only check the extent of their IPR portfolio, but also to be vigilant in ensuring whether or not the standard is developing in a direction that would cover their IPRs. While this may result in overly cautious participants engaging in over-disclosure of patents, it would at least give the SSO's technical committees a complete picture of the IPR landscape in which it is standardising. In the Rambus case there was suspicion of the IPRs that Rambus held. Had a policy similar to the one proposed been in place, Rambus would certainly have been much more co-operative in its disclosure policies. Not only would this have given JEDEC the requisite patent information to assess the potential fees that would be owed to Rambus (on Reasonable and Non-Discriminatory grounds) it would have also aided it in its decisions as to whether some other technological path should have been chosen.

3 Article 102 – Abuse of a Dominant Position

There will be situations where there has been no need for horizontal co-operation on the market for a standard to emerge. If a company possesses a sufficient market share, the technology choices they take could alone determine what standard may gain widespread adoption (de facto standard setting). That company will therefore have a huge influence on how the industry may operate.[53] Competition law does place some limits on the scope of this

[51] It should also be noted that it would be likely that patent ambush cases would be brought against a number of the competing SSO participants.

[52] *Rambus, Inc, v. Infineon Technologies AG*, Docket Nos. 01-1449, -1583, -1604, -1641, 02-1174, -1192 (2003) U.S. App. (Fed. Cir. January 29, 2003).

[53] Arthur, "Competing Technologies: An Overview" in Dosi et al., (eds.) *Technical change and economic theory* (1988, London).

power, however it has been traditionally adverse to forced licensing of the IPRs of a dominant firm, unless some exceptional circumstances exist.[54]

Although not directly related to technological standardisation, the most famous example involved Microsoft[55] and their operating system and subsequent software platforms. This case does not refer to standardisation, but the case does demonstrate the power that a dominant firm can wield over an industry, heavily influenced by network effects,[56] particularly when that firm refuses to licence rights to that dominant technology.

It is only in exceptional circumstances that the European Competition law will force a dominant firm to license its IPRs. The *Magill*[57] case is one of the most important cases on the matter of refusals to license. The case revolved around television listings information, capable of copyright protection under UK and Irish law[58] by the Irish television networks. Magill wanted to produce a consolidated version of television listings, however the television companies refused to grant him a licence in the IPRs. Ultimately the Commission, upheld by the European Court of Justice (ECJ), forced the television companies to grant Magill a licence in the information.

The court found that only in "exceptional circumstances"[59] could the exercise of an IPR infringe Article 102. These exceptional circumstances are;

1. The refusal to supply prevents the emergence of a new product as there is no substitute for the IPR in question.[60]
2. No objective justification exists to justify the refusal.[61]
3. The IPR holders are reserving for themselves the secondary product market.[62]

On the face of it, these exceptional circumstances are similar to the U.S. "essential facilities" doctrine.[63] However this term is rarely used in the European context. The terms can be differentiated[64] by relating exceptional circumstances to intangible assets, such as IP, and essential facilities to tangible assets.[65]

The *Magill* case was re-stated in the *IMS Health* case. This case revolved around the use of, what had become an industry-wide *de facto* standard, for a brick structure geographically recording German pharmacies into 1860 pharmacy groups. This standardised "1860 Brick

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[54] Ahlborn, Evans and Padilla, "Logic & Limits of the "Exceptional Circumstances Test" in *Magill* and *IMS Health*" (2004) 28 *Fordham International Law Journal* 1109.
[55] Case T-201/04, *Microsoft Corp. v Commission* , [2007] E.C.R. 3601.
[56] Pardolesi and Renda, "The European Commission's Case Against Microsoft: Kill Bill" (2004) 27 *World Competition Law and Economics Review* 513, 521.
[57] Joined cases C-241/91 and C-242/91, *Radío Telefis Éireann (RTÉ) and Independent Television Publications Ltd (ITP) v. Commission* [1995] E.C.R. I – 743.
[58] The copyrights in this case created a controversial aspect to the decision, with authors suggesting that it influenced the decision of the Commission and ECJ. See; Whish, *Competition Law* (2009. 6th Edition, Oxford) 788.
[59] Joined cases C-241/91 and C-242/91, *Radío Telefis Éireann (RTÉ) and Independent Television Publications Ltd (ITP) v. Commission* [1995] E.C.R. I – 743, para 50.
[60] *Ibid* at para 52-54.
[61] *Ibid* at para 55.
[62] *Ibid* at para 56.
[63] Opi, "Application of the Essential Facilities Doctrine to Intellectual Property Licensing in the European Union and the United States: Are Intellectual Property Rights Still Sacrosanct?" (2000) 11(2) *Fordham Intell. Prop. Media & Ent. L.J.* 409.
[64] Park, *op. cit.* 61.
[65] For e.g. of tangible assets application of the rule in Europe, see; Joined cases 6-73 and 7-73, *Istituto Chemioterapico Italiano S.p.A. and Commercial Solvents Corporation v European Commission* [1974] E.C.R. 223.

Structure" became invaluable to anybody wishing to sell into the German pharmaceutical market. Two cases emerged from the use of the brick structure. The first was a Court of First Instance (CFI) decision[66] that overturned a Commission decision[67] that found that IMS had abused its position by refusing to license what had become an industry standard. The Commission based its decision heavily on the fact that the 1860 Brick Structure was a *de facto* industry standard, carrying out extensive research to prove this point.[68] The CFI president overturned this based on the fact the Commission had failed to fully interpret the requirements of Magill, through excluding the need to show that a new product was involved.[69] This effectively established the fact that the three conditions for exceptional circumstances in Magill are cumulative.[70]

Further clarification of the law as stated by CFI was provided by the ECJ, as it had the opportunity to look at the case thanks to a separate reference by a Frankfurt court. The ECJ stated that it would only be an abuse of dominant position, if there was a refusal to license when the three conditions as set out in *Magill* are not met.[71]

It can be argued that the *IMS Health* case is of particular relevance to the topic at hand. It can be particularly relevant in the standards context due to the fact that the 1860 brick structure had all the characteristics of an industry standard,[72] established by network effects. As more pharmaceutical companies joined the structure, the structure became more valuable to those companies. While this is true, it is contended that this is a weak method of establishing the importance of this case to situations involving industry standards. It is advocated that there is a much more relevant aspect to this case that suggests its importance to standardisation jurisprudence. It is submitted that a close look at the Commission decision, even if it was over turned, is vital in an examination of Article 102 and its relevance to standardisation. The Commission decision heavily relied on the fact that the structure had become an industry standard. It states that the industry had become "locked in" to the standard to such an extent "that to switch away from it to buy sales data formatted in a non-compatible structure, whilst theoretically possible, would be a unviable economic proposition."[73] Whilst the Commission did exclude the need to prove that there was a potential secondary market, it is clear that the most important consideration for the Commission was that IMS held total control of an industry standard. The fact that this Commission decision was effectively overridden twice, first by the CFI and then by the ECJ, clearly suggests that this theory did not hold any sway with the courts. It is clear that the courts will not require the licensing of IPR necessary for a standard, unless there is the possibility for a new secondary market. Therefore standards set by a dominant firm, can be protected by that firm, through its refusal to license to others to manufacture on that dominant firm's market.

The Commission has been active at investigating firms under Article 102, in relation to standard setting. For instance in the *Qualcomm* case, it was alleged that Qualcomm did not abide by FRAND commitments when licensing its technology required for mobile telephones,

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[66] Case T-184/01 *IMS Health v Commission* [2001] E.C.R. II-3193.
[67] Commission Decision of 3 July 2001 relating to a proceeding pursuant to Article 82 of the EC Treaty (Case COMP D3/38.044 — NDC Health/IMS Health: Interim measures).
[68] *Ibid* at para 86.
[69] The Commission was criticised at the time for not precisely following the requirements for exceptional circumstances as set out in *Magill*. See; Korah, "The Interface Between Intellectual Property and Antitrust: The European Experience" (2002) 69 *Antitrust LJ* 801.
[70] Case T-184/01 *IMS Health v Commission* [2001] E.C.R. II-3193, para 101.
[71] Case C-418/01, *IMS Health v NDC Health* [2004] E.C.R. I-5039, para 52.
[72] Park, *op. cit.* 82-84.
[73] Commission Decision of 3 July 2001 relating to a proceeding pursuant to Article 82 of the EC Treaty (Case COMP D3/38.044 — NDC Health/IMS Health: Interim measures) para 92.

specifically in relation to the 3G standard.[74] Initially the Commission had alleged that Qualcomm's actions amounted to an abuse of its dominant position, under Article 102. Qualcomm later settled these complaints with the individual companies concerned,[75] allowing the Commission to close down its investigation.[76]

More recently, the interplay between the Article 102 and the standardisation process has been analysed by the European authorities, including the ECJ (now the Court of Justice of the EU) through the fallout of Apple and Samsung's patent wars[77] and the licensing of Standard Essential Patents (SEPs)[78]. In the *Huawei* case,[79] the ECJ has confirmed that an action for a prohibitory injunction against an alleged infringer brought by a dominant holder of a SEP (who has provided undertakings to a SSO to grant a licence on FRAND terms) may constitute an abuse of dominance pursuant to Article 102. However, the ECJ limited this by setting out the specific circumstances where such abuse would occur. Abuse would not occur where, prior to bringing the action, the SEP holder alerted the alleged infringer of the infringement and presented a specific, written offer for a licence on FRAND terms specifying, in particular, the royalty and the way in which it is to be calculated. Furthermore, there will be no abuse by the SEP holder if, the alleged infringer has not responded to the offer, in accordance with recognised commercial practices in the field, (which will be determined objectively). Finally, an infringer which has not accepted the offer made by the SEP holder will only be in a position to claim abuse under Article 102 (on the bringing of an injunction application by the SEP holder), if it has submitted to the SEP holder, a specific counter-offer that corresponds to FRAND terms.[80]

These (heavily convoluted) requirements again demonstrates the European Courts reluctance to mandate licensing in relation to an Article 102 breach. The *Huawei* judgment includes very specific criteria, to such a prescriptive extent, which even by codified civil law systems of central Europe, is quite unusual. It is clear that the ECJ was being extremely cautious in restricting the extent of Article 102 in these cases and did not wish to punish a dominant SEP holder merely based on the dominance itself.

4 Conclusion

In conclusion, in the situation of a firm legally holding almost total dominance over a network industry, resulting in the unavoidable loss in competition, it has been accepted that there is little that can be done. Korah notes that:

> "There is little a competition authority can do to enable competition to develop in a network industry other than ensuring that competition for the next generation of technology and for linked markets of complementary products remains open so that there is competition *for* the market."[81]

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[74] Commission, *Antitrust: Commission initiates formal proceedings against Qualcomm* (2007) MEMO/07/389.
[75] Sattler, "Standardisation under EU competition rules – the Commission's new horizontal guidelines" (2011) 32(7) *European Competition Law Review* 343, 347.
[76] Commission, Antitrust: Commission closes formal proceedings against Qualcomm (2009) MEMO/09/516.
[77] European Commission Decision, *Case AT.39939 - Samsung - Enforcement of UMTS standard essential patents*, C(2014) 2891 Final.
[78] European Commission, "Antitrust: Commission sends Statement of Objections to Motorola Mobility on potential misuse of mobile phone standard-essential patents- Questions and Answers" (2013) MEMO/13/403.
[79] Huawei Technologies Co. Ltd v ZTE Corp. [2015] Case C□170/13.
[80] *Ibid* para 65.
[81] Korah, *Intellectual Property Rights and the EC Competition Rules* (2006, Oxford) 153.

Obviously it would be far beyond the remit of the European Commission to investigate the holder of an IPR, based solely on the fact that their standard has been widely adopted by the market. Quite often that company will have got into that position due to the superior performance of the technology / standard. It must be remembered that these are standards that would have already won the “allegiance of the market.”[82]

This reluctance can be contrasted against the liberty that the Commission has taken in regulating standard-setting related activities, with Article 101. Through the implementation of the 2011 guidelines, compliance with Article 101 is important from an earlier stage in the standardisation. Unfortunately, this would seem to have the effect that standardisation through consensus, needs to be aware of legal regulation to an extent far greater than standardisation established by dominance on the market.

[82] Utterback, *Mastering the Dynamics of Innovation* (1994, Harvard).

Competency needs of engineers in standardization

Sandra Drechsler, Albert Albers

Karlsruhe Institute of Technology
sandra.drechsler|albert.albers@kit.edu

Abstract: *Nowadays standards are getting more and more important for various reasons. They can be used for example to ensure compliance to legal requirements, compatibility to systems and components or to gain market entry to certain markets. A trend expected to further increase. One area where standards are of significant importance is the field of mechanical engineering and automotive industry, resulting in a demand of standardization specific knowledge of employees, which is not sufficiently present. One reason is a lack of teaching standards in higher education; nevertheless the need has been addressed in several studies. According to an actual development universities are obliged to alter their curricula and to switch from content based education to competency based education, which is based on skills and competencies. An analysis of the state art shows that current teaching approaches are content based and not aligned to actual needs of different target groups. Therefore a competency model for standardization has been developed considering activity specific requirements. All formulated competencies have been evaluated within a quantitative study by a group of product developers. The study leads to the most important competencies in the field of standardisation for mechanical engineers. Additionally the main influencing factors on particular requirements have been determined. Thus it can be shown that actual demands depend on activities within standard setting, company size, sector of activity, highest degree of an employee and professional experience. The available results allow developing a competency based curricula, which meet the requirements of future academic education.*

1 Introduction

Today's world is characterised by increased globalisation, shorter product life cycles and tougher competition. As a result, companies' actions are increasingly influenced by one or more standards which, for various reasons, are becoming more important. Against this background, the requirements on an employee have increased, as guidelines and standards influence ever further reaching areas of their tasks. On the one hand, products need to be designed according to standards, and on the other hand, companies need to actively participate in standardisation processes to ensure that resulting standards have a positive impact on them themselves. Both aspects are only considered marginally, whereas the reasons are seen as a lack of awareness of the relevance of standards as well as a lack of knowledge of the employees. One possibility to address these problems is to strengthen education in this field; nevertheless the need has been addressed in several studies. A demand which is even expected to grow in the future, cf.(Hövel & Schacht, 2013), (The Center for Global Standards Analysis, 2008). It shows at the same time, that the requested implementation of particular contents has not been put into practice, e.g. (Kurokawa, 2005), (de Vries & Egyedi, 2007), (Krechmer, 2007), (Cooklev & Bartleson, 2008), (Albers, et al., 2014). Moreover, all available teaching approaches focus on subjects (e.g. business administration) and an active participation in consortia. However, independently of the subject, not all employees work with to the same level of intensity. The relevance depends on the particular position of an employee, thus the requirements of specific competencies vary. Deeper research concerning the role of standards in daily work lead to the result, that one target group for standardisation education are employees who use standards within their daily work. Such an example would be product developers who have to ensure the products and processes are designed according to a given standard. Thus it has to be investigated which competencies a product developer needs to have to handle his tasks. Within the context of this paper, competency is regarded as learnable, through context specific performance dispositions (Weinert, 2002). The elementary abilities and their connections in a hierarchical way are described in competency models by means of competency dimensions. The main resulting contribution of this paper is a first detailed competency model for the topic of standardisation considering product developers.

2 State of the art

2.1 Demands in standardization education

The state of research concerning special demands for standardization education can be distinguished in two different perspectives: the universities and the companies' point of view.

From universities perspective a demand for standardisation education has been formulated for engineering, economics and natural sciences, e.g. (Hesser & de Vries, 2011), (Hövel & Schacht, 2013), (Krechmer, 2007). Several studies point out especially engineering courses. As the demand of knowledge depends on the particular position of an employee each student would benefit from standardisation knowledge (de Vries, 2002). Thus defined target qualifications are quite general.

The results from companies' perspective are quite similar, as there is no uniform definition of target groups and their particular demand of standardisation education. (Hesser & de Vries, 2011) identify a need for "standard engineers" without any further descriptions of this particular position. According to job offers they should have following competencies and abilities "*a) being aware of interpreting standards, b) standards development, c) standards implementation, d) standards compliance/ certification/ inspection/ evaluation, e) standards diffusion/ training*" as well as soft skills. These standards engineers are usually technical experts for the development of standards in standardization committees. Additionally two other demand groups have to be added: employees in standardization departments, who are main contacts and coordinators for all standardization activities within a company and managers, making strategic decisions about standardization activities (Hesser & de Vries, 2011). (Cooklev & Bartleson, 2008) identify a need for special trainings for employees in product development, sales and management. (Kurokawa, 2005) distinguish between general users, employees working with standards and employees working with standards strategically. He proposes a general education within this topic, e.g. implementation of standards within a company. The third group has a demand for additional knowledge e.g. standardisation organisations, standards and patents or the national standardisation strategy. However, (Drechsler & Albers, 2016) differentiate between employees using standards and employees creating standards. Each group can be distinguished further by the intensity of standard usage and assignment to different departments, leading to 4 target groups with different demands of standardisation education. A study of required competencies of each target group leads towards a first competency model.

2.2 Teaching standards in higher education

Worldwide available standardisation education approaches are fundamentally different. Especially Asian countries are increasingly implementing standardization education programs. China set up former several Bachelor – and Master programs to educate experts with standardization knowledge and experience, enabling them to participate in standardization committees; an approach which failed. As an answer standardisation as compulsory subjects has been implemented in several degree courses (Drechsler, et al., 2015).

The Korean government has set up a "University Education Promotion on Standardisation (UEPS)", which consists of different general modules and some specific ones, e.g. mechanical engineering (Choi & de Vries, 2013). Osaka University in Japan has a similar approach but on university instead of national level (Nakanishi, 2013). Some European universities have implemented standardization as an elective course in their curricula of different degree courses, whereas the number is manageable. The topic of standardisation is integrated in subject specific lectures up to a certain degree, especially in mechanical- and electrical engineering, business administration and information technology (Hesser, 2014). A study across Germany confirms this observation (Butenko, et al., 2015).

Regarding skill and ability development in standardization, hardly any activities exist. Single activities can only be found in the US. According to (Kelly, 2003) criteria 4 of the ABET "*requires students to use engineering standards in a major design experience*". Thus students should research certain standards and use them within a design project. In final step of this project work they should check if their design is in compliance with European guidelines. (Reisdorph, 2008) from Oklahoma State University indicate, that the ABET criteria are not sufficient for the degree course *Sustainability*. He introduced a project work with the goal to teach students how to develop a standard.

The majority of researchers are convinced, that especially engineers benefit from a special education, e.g. (Hesser , 2011), (Krechmer, 2007), (Hövel & Schacht, 2013), (Fields, 2008), (Rosiawan, 2013), (Kam, 2010). According to the number of mentions the aspect "application of standards" is quite important, followed by basics of standardization and development/ creation of standards. Interestingly these topics are mentioned but hardly described in detail, e.g. the requirements to successfully apply a standard are not specified. Furthermore standardization is mostly offered as an elective subject as method of choice, while teaching standards within the context of other subjects is refused in several studies. The curricula are mostly designed from a strategic perspective of standardisation, while standard application as an activity is only considered marginally. For example target-oriented research of certain standards within design projects is an exceptional case. Even though (Kam, 2010) and (Kelly, 2003) claim an integration of these particular contents in engineering education, the requested implementation has not been put into practice.

2.3 Competency models for the topic of standardization

Nowadays universities are altering their curricula from content based education to competency based education. This type of education is based on skills and competencies (Chiru, et al., 2012). Against this background it is notable that most teaching approaches in standardization education are content-based. However, ccompetency based education clearly postulates learning objectives and defines them in terms of competencies, focusing on the ability to apply the acquired knowledge in useful and functional practices (Ford, 2014). Competency, if defined as a socially situated concept, is an ability to handle tasks to a certain expected standard, which can be applied to a professional employee at any stage. With regard to a company, competence is the ability to perform tasks to the expected standard of a particular job (Delamare le Deist & Winterton, 2005). Within the context of this paper competency is regarded as learnable, context specific performance dispositions according to (Weinert, 2002). The elementary abilities and their connections in a hierarchical way are described in competency models by means of competency dimensions, whose quantity varies depending on the particular field of interest. The competency dimensions itself can be independent of each other or hierarchical related to each other. Frameworks for generic competency models provide for example the Bloom's taxonomy, which create a common language between and among educators (Conkling, 2005).

As competencies rely heavily on the demands of the economy a tight cooperation between industry, education bodies and government is essential. First it is necessary to define core abilities and demands in selected competency areas with the aid of several means, including interviews, observations, questionnaire surveys and research investigations, whereas interviews play a key role as a survey tool for qualitative empirical study with a great significance of practical experience (Albers, et al., 2015). Based on these core abilities and demands a competency model can be developed. The first competency based approach deliver (Albers, et al., 2014) by developing a competency model for standardization based on a qualitative study across the German industry, e.g. engineering companies, insurances, banks and hospitals. Consequently the competency model is built general and doesn't provide specific activity based competence profiles, e.g. for engineers.

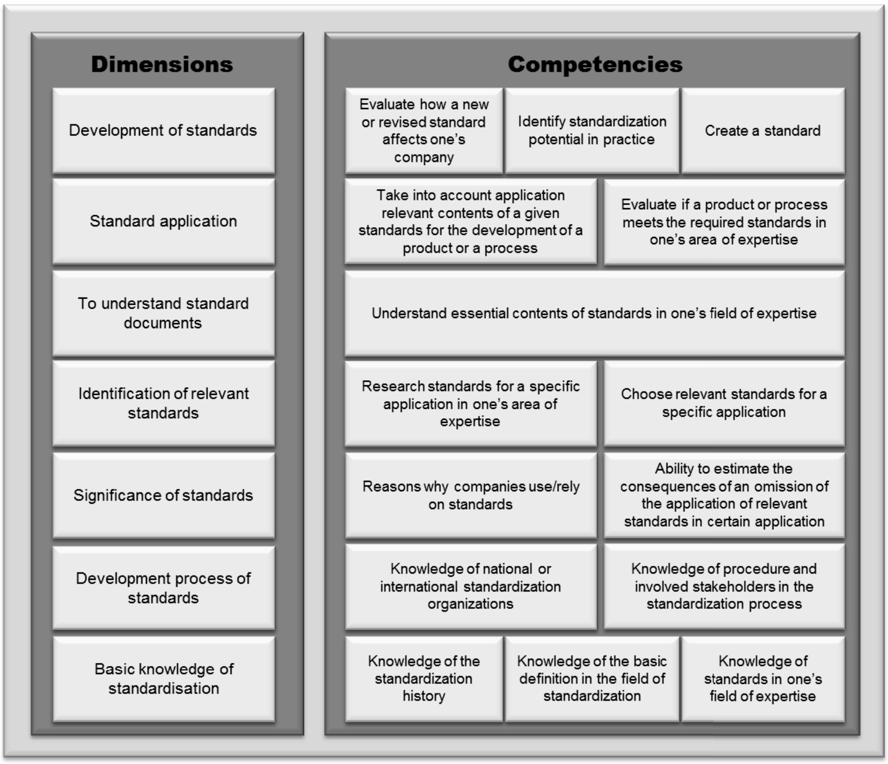


Figure 1: General competency model (Albers, et al., 2014)

Each vocational domain such as mechanical engineering has got specific demands for abilities. Therefore detailed cognitive processes from generic models should be consolidated into relevant competence dimensions for a specific field, leading to a stronger focus on some cognitive processes (e.g. factual or procedural knowledge) within the domain-specific competency model (Albers, et al., 2015). Additionally (Drechsler & Albers, 2016) develop a first specific competency model for mechanical engineering based on the results of an interview study. Unlike the general model (***Figure 1***) the domain specific one considers hierarchical relations between single competencies, cf. ***Figure 2***.

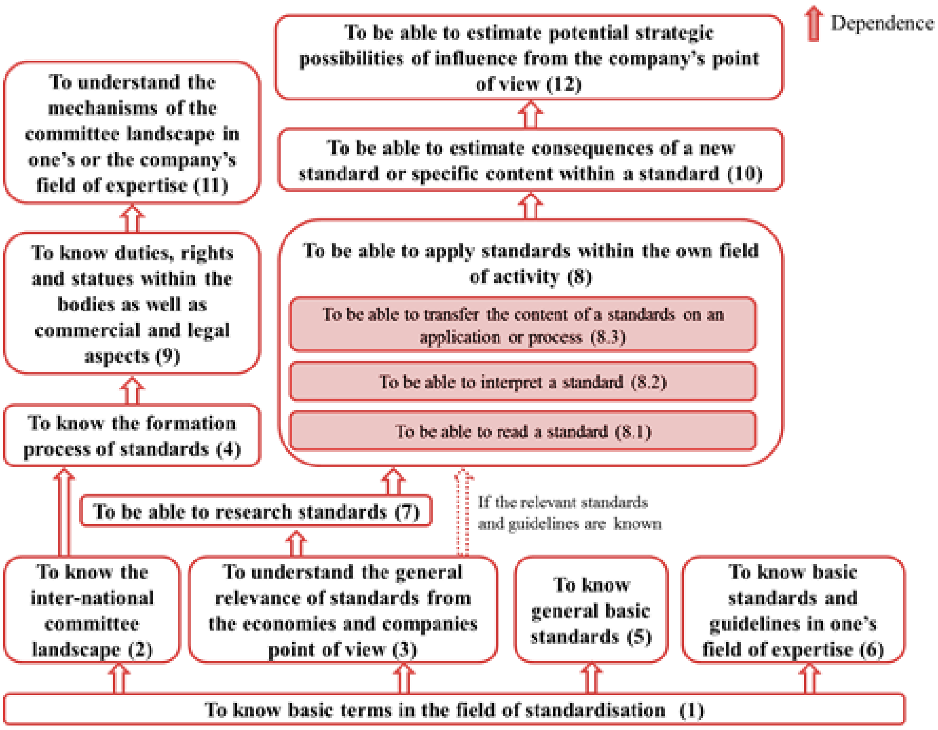


Figure 2: Domain-specific competency model for mechanical engineering (Drechsler & Albers, 2016)

3 Objectives

Against the state of research standardization knowledge and understanding is highly relevant for economies. Thus a high company-sided demand of standardization specific education can be expected. An analysis of the current implementation of the topic in curricula at universities and the proposed teaching contents in the state of research lead to the following gaps:

- Current research in standardization education distinguish between subjects, e.g. engineering sciences and economics, but not on the level of industrial sectors (e.g. mechanical engineering, automotive industry, electrical engineering), whereas the demands of a particular sector might be different.
- All proposed curricula are content-, instead of competency-based
- Required competencies an employee needs to have in the field of standardization to handle his tasks have not been identified yet
- The requirements on standardization specific knowledge of an employee depend on the particular position of an employee, as not all employees work with standards to the same level of intensity – a fact which has not been considered in the state of research yet.

According to the state of research, engineers are one main target group for standardisation education. The aim of this paper is to introduce a first detailed competency model for the topic of standardization considering specific demands of product developers. A competency model for the topic of standardization has been developed previously, which allows describing elementary abilities and their connections in a hierarchical way. Within a next step all formulated competencies shall be evaluated to identify the most important competencies and to determine main influencing factors on particular demands.

4 Research methodology and data

To achieve the formulated goals, the research approach has been built up multistage:

1.) The evaluation of the competencies is carried out by an online survey (cf. chapter 4.1). This method allows a precise, clearly and condensed constitution of the data (Hussy, et al., 2013).
2.) To be able to understand and to explain certain characteristics of the evaluation (chapter 4.2) the results shall be discussed and assessed by a group of experts. This inquiry is carried out by interviews, which can be used to reconstruct meaning (Hussy, et al., 2013).The personal interaction with the interviewee allows to discuss certain aspects in detail and to adapt the course of the interview flexible.

4.1 Methodology and data of the online survey[1]

The aim of the online survey is the evaluation of each competency to identify the most important ones for product developers (engineers). In order to increase the acceptance of the survey by the participants and to be able to address private issues, the survey is anonymous and doesn't contain any attribute information enabling to identify the participants.

The questionnaire has been sent to 560 graduates of our university with a degree in mechanical engineering. The year of graduation is in the range between 1983 and 2015. Altogether 155 questionnaires have been sent back, of which 101 are complete. The structure of the sample can be summarized as followed:

- 74% of the participants work in large scale companies (>500 employees) and 26% in SME's (<500 employees).
- 55% of the participants hold a Diploma/ Master Degree and 45% a PHD, whereas 78% of the participants hold a degree in mechanical engineering (78%) and 22% degrees in mechatronics and electrical engineering.
- 75% of the participants work in R&D, 6% in management and 19% in other departments

With regard on the sector and department of activity the sample has the following structure:

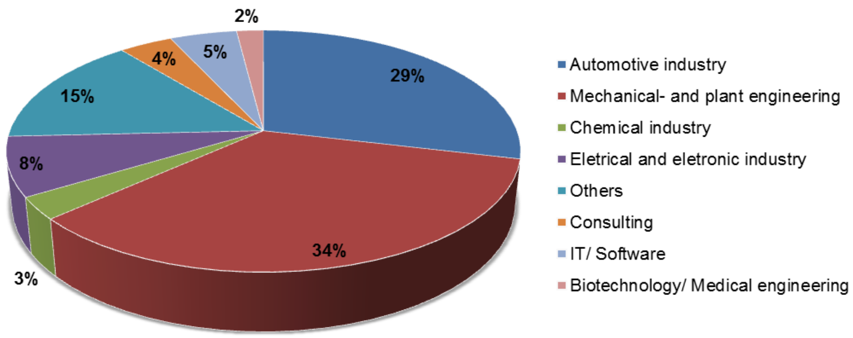


Figure 3: Sector distribution of the sample to identify competency demands in the field of standardization

The questionnaire itself consists of 14 questions and can be structured in 5 sections. Within one all participants are asked to evaluate each competency (cf. ***Figure 1***) on a scale between 1 and 4:

1- Not relevant for the handling of my tasks

[1] The methodology and the questionnaire for the online survey have been developed within a master thesis in the course of a research project at our institute. We would like to thank Aychin Rahimova for her excellent work and support.

2- *Helpful in handling my tasks*

3- *Advantageous for the handling of my tasks*

4- *Essential for the handling of my tasks*

To simplify the subsequent analysis the competencies are allocated to numbers:

Number	Competency
K1	Knowledge of the standardization history
K2	Knowledge of the basic definition in the field of standardization
K3	Knowledge of standards in one's field of expertise
K4	Knowledge of national or international standardization organizations
K5	Knowledge of procedure and involved stakeholders in the standardization process
K6	Reasons why companies use/rely on standards
K7	Ability to estimate the consequences of an omission of the application of relevant standards in certain application
K8	Research standards for a specific application in one's area of expertise
K9	Choose relevant standards for a specific application
K10	Understand essential contents of standards in one's field of expertise
K11	Take into account application relevant contents of a given standards for the development of a product or a process
K12	Evaluate if a product or process meets the required standards in one's area of expertise
K13	Identify standardization potential in practice
K14	Evaluate how a new or revised standard affects one's company
K15	Create a standard

Figure 4: Overview competency classification

4.2 Methodology and data of the interview study

The results of the previous study are prioritized competency profiles. To be able to understand and to explain differences and reasons for a certain evaluation deeper knowledge about the importance of standards for and in daily work is necessary. To achieve that goal semi-structured expert interviews have been carried out with 14 product developers (pre- and serial development) and 3 standardisation experts. All companies within this study work in mechanical engineering or automotive industry. For confidentiality requirements, their names have not been provided. All interviewees have been asked to evaluate each competency according to their particular demand in daily work. Within this context the assessments of the participants of the online survey have been discussed in detail for underlying reasons. For the purposes of this paper, only a selection of the results will be presented where necessary.

5 Results and discussion

5.1 Extension of the domain-specific competency model

The online survey is based on the general competency model presented in ***Figure 1***. Within this study we investigate the importance of each competency for product developers. Hence the aim is to present the results in the domain-specific competency model (cf. ***Figure 2***). As the models are based on results of an interview study the results of the online survey can be used to validate the model. First of all we need to bring both models together to develop an extended domain-specific competency model. As a result of a comparison, the specific one needs to be extended by following competencies: Knowledge of standardization history, Create a standard (a), Identify standardization potential in practice (b), Evaluate if a product or process meets the required standards in one's area of expertise (c), Choose relevant standards for a specific application (d) and Ability to estimate the consequences of an omission of the application of relevant standards in certain application (e). Apart from knowledge of standardization history, all other competencies show a higher or less relevance. Consequently standardization history is not taken into account any further. Within a next step particular connections between single competencies need to be identified, to be able to consider hierarchical relations:

(a) A person who wants to *create a standard* of practical relevance need to be able to apply a standard. Additionally general knowledge about the procedure of the standardisation process as well as knowledge about the National, European and International committee landscape is necessary.
(b) The competency "*Identify standardization potential in practice*" can be seen from 2 different perspectives:
    a. An employee should be able to identify standardization potential in products or processes within the own company. These standards are specified in design guidelines, process instruction or company standards.
    b. An employee should be able to identify standardization potential, a company could introduce proactively in external consortia by initiating a standardization project.

    Resulting competency requirements are completely different, depending on the case. Consequently this competency needs to be investigated and defined more detailed in further research and is not taken into account within this paper.
(c) To able *to evaluate if a product or process meets the required standards in one's area of expertise*, the respective employee needs to be able to understand essential contents of a standard. This activity is analytical in nature. However, the synthesis ("*Take into account application relevant contents of a given standards for the development of a product or a process*") is no necessary condition for this competency; they stand alongside.
(d) The competency *to choose relevant standards for a specific application* requires being able to research standards.
(e) The ability *to estimate consequences of an omission of the application of relevant standards in certain application* is strongly connected with the ability to choose a standard. Within a preselection process relevant standards need to reviewed and preselected. Thus an employee already estimates possible consequences in his decision implicitly to keep or to reject a standard. Consequently these two competencies built an iterative process.

An extension of the specific competency model by these competencies leads to competency model illustrated in *Figure **5***.

5.2 General prioritization of competency demands

Most companies within mechanical engineering and automotive industry actively use standards, especially for legal reasons or to gain market authorization, e.g. (DIN, 2000). Thus it can be concluded that a goal-oriented implementation of standards in products and company processes is significant for the success of a company.

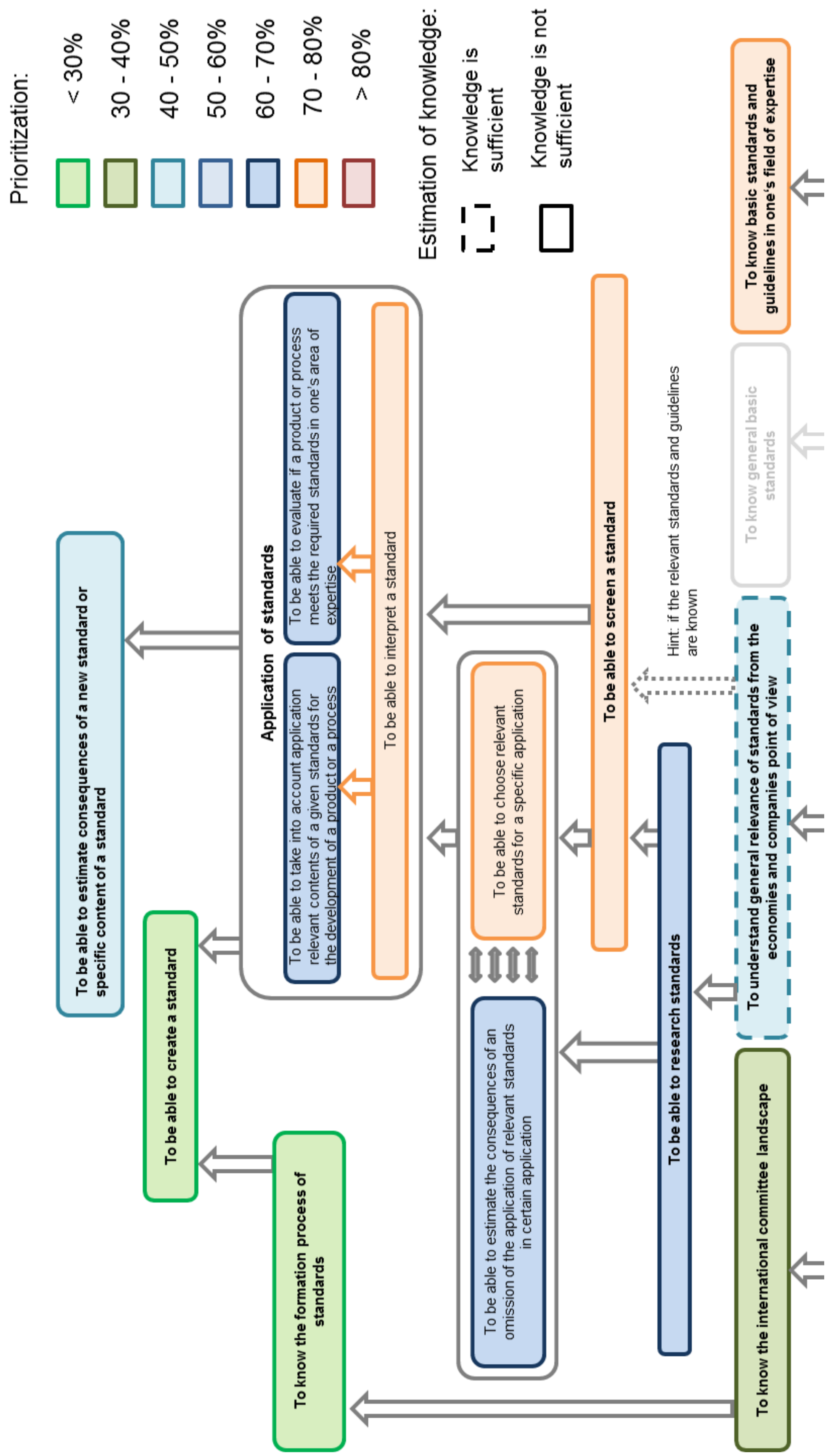
According to the results of the survey the Top 5 competencies evaluated as „*Essential for the handling of my tasks"* are:

- Understand essential contents of standards in one's field of expertise (56% of the participants)
- Knowledge of standards in one's field of expertise (50% of the participants)
- Evaluate if a product or process meets the required standards in one's area of expertise (50% of the participants)

- Ability to estimate the consequences of an omission of the application of relevant standards in certain application (49% of the participants)
- Choose relevant standards for a specific application (43% of the participants)

Whereas less essential evaluated are: Knowledge of procedure and involved stakeholders in the standardization process (10% of the participants), Create a standard (10% of the participants) and Knowledge of the standardization history (1% of the participants). As K1 *Knowledge of the standardization history* is evaluated by 87% of the participants as "*Not relevant for the handling of my tasks"* it is not further considered.

From an educational perspective level 3 (Advantageous to handle one's tasks) and 4 (*Essential to handle one's tasks)* of the evaluation scale are both relevant to handle professional tasks. Hence the numbers of mentions are summed up (Figure 5). Additionally the participants have been asked to assess for each competency if the knowledge acquired at university is sufficient. Apart from *Knowledge of basic terms* and *General relevance of standards* all competencies are evaluated as insufficient. All application-oriented competencies are higher assessed than non-application-oriented competencies (e.g. *to know the formation process of standards)* generally. All competencies directly related to the creation of standards are evaluated as low important (<30%). None of all competencies is evaluated *advantageous* or *essential* by more than 80% of the participants of the whole sample.



Prioritization:
< 30%
30 - 40%
40 - 50%
50 - 60%
60 - 70%
70 - 80%
> 80%
Estimation of knowledge:
Knowledge is sufficient
Knowledge is not sufficient
To be able to estimate consequences of a new standard or specific content of a standard
To be able to create a standard
To know the formation process of standards
Application of standards
To be able to evaluate if a product or process meets the required standards in one's area of expertise
To be able to take into account application relevant contents of a given standards for the development of a product or a process
To be able to interpret a standard
To be able to choose relevant standards for a specific application
To be able to estimate the consequences of an omission of the application of relevant standards in certain application
To be able to screen a standard
To be able to research standards
Hint: if the relevant standards and guidelines are known
To know basic standards and guidelines in one's field of expertise
To know general basic standards
To understand general relevance of standards from the economies and companies point of view
To know the international committee landscape

Hence the most important competencies are:

- *to know basic standards and guidelines in one's field of expertise*,
- *to be able to choose relevant standards for a specific application*
- *to be able to apply standards within the own field of activity*.

However, *to know the international committee landscape* is only assessed as advantageous or essential to handle their professional tasks by 38% of the participants within this study. The majority of the participants works in R&D and is employed in large scale companies. The focus within R&D lies on standard implementation, as relevant standards need to be considered in the design of products and processes. The creation of standards is of lower importance for a single employee in daily work. Additionally most large scale companies have a standardization department at their disposal (Blind, et al., 2014), whose main task is to identify relevant consortia and to ensure that the own company is represented by a suitable person (Drechsler & Albers, 2016). Thus the competency *to know the international committee landscape* is not considered as relevant by most participants within this study. Consequently most of the employees are not aware of the fact, that this competency is a key condition *to be able to research standards and guideline* purposefully. The competencies *to know basic terms of standardization* and *to understand the relevance of standards from the economies and companies point of view* are evaluated as comparatively low important as well.

The interviewees within the second study indicate that both competencies offer no added value considered in isolation. However, they are aware of the importance of tacit knowledge in both areas as basic knowledge for other competencies.

5.3 Determination of main influences on competency demands

In a next step key factors shall be identified which have a main influence on the response behavior of the participants within the study.

5.3.1 The activity of an employee within standard setting

One activity which can be expected to strongly influence required competency demands of an employee is committee work. In addition to be able to implement standards, these employees need to be able to set standards. (Drechsler & Albers, 2016) conclude within their study that employees involved in standardization need a strong technical background and the ability to abstract, transfer and evaluate issues. Furthermore soft skills are essential, e.g. communication, assertiveness and the ability of consensus building. However, the divergent emphasis of topic-specific competencies in standardization has not been addressed within their study. Within this context the term *setting standards* means to introduce new topics, to produce new ideas, to bring in technological knowhow and to push the standardization process in external committees or consortia. To simplify the wording we define within this paper:

Standard setter: Employees who actively develop standards in committees.

Standard users: Employees, who do not actively develop standards in committees, but use them in daily business. (This proposition is acceptable within this paper, because 100% of the participants within this study use standards in daily work.)

To investigate if the response behavior of standard setters (group 1) differs from standard users (group 2) we use a T-Test for independent variables, cf. ***Table 1***.

Table 1: The influence of committee activities on competency demands of employees – results of an inquiry (Extract)

		N	Average	Standard deviation	F	Significance	Sig. (2-seitig)	Average difference	Standard error of the difference	95% confidential interval	
										minimum	maximum
K4	1,0	19	2,842	,9582	2,249	,141	,011	,7350	,2774	,1762	1,2937
	2,0	28	2,107	,9165			,012	,7350	,2799	,1682	1,3017
K6	1,0	19	2,947	,8481	,529	,471	,044	,5902	,2850	,0162	1,1643
	2,0	28	2,357	1,0261			,037	,5902	,2747	,0363	1,1442

The results show a significant higher relevance of the demands "*to know the international committee landscape*" (K4) and "*to understand the general relevance of standards from the economies and companies point of view*" (K6) for standard setters. However, the competency "*to know the formation process of standards*" is only marginal significant higher evaluated by standard setters. However, the competency "*to be able to write a standard*" (K5) is assessed tantamount for both groups.

5.3.2 The company size

According to the state of the art the company size has a significant influence on the likelihood of a company to participate in standardization and to implement standards, (Hesser, et al., 2010), (Müller, et al., 2008). Consequently it can be assumed that the company size has an influence on competency demands of employees in the field of standardization. The majority of the participants within this study are employed in companies with more than 500 employees, whereas the group of SME's is comparatively small. Hence we distinguish between two groups: Large scale companies (group 1) and SME's (group 2). To investigate, if the company size has an influence on the response behavior of the participants, we use a T-test for independent variables, cf. ***Table 2***. The results of the calculation show that the company size has no influence on 14 out of 15 competencies within our study. Only the competency K8 "*to be able to research standards*" is significantly higher evaluated by SME's.

Most large size companies have a standardization management system which contains already known standards and guidelines simplifying the whole research process. Additionally they mostly have a centralized standardization department which is responsible for the purchase of new documents. However, within SME's these tasks are part of the responsibility of each employee. Furthermore relatively high fees accrue for Perinorm licenses. Especially small companies within our interview study indicate not being able to afford these costs. Consequently they need to get access to the necessary documents by buying them single resulting in a higher research effort.

Table 2: T-Test to determine the influence of the company size

		N	Average	Standard deviation	F	Significance	Sig. (2-sides)	Average difference	Standard error of the difference	95% confidential interval	
										minimum	maximum
K8	1,0	25	3,28	0,792	5,48	0,021	0,062	0,459	0,243	-0,024	0,942
	2,0	67	2,82	1,114			0,032	0,459	0,209	0,042	0,877

5.3.3 The academic degree of an employee

Approximately 62% of the engineers holding a doctorate have a leading position in the top or middle management (Acatech, 2008). Instead of working in detail on a special product or process they are superior responsible for a larger field of activity and depending on their particular function for the strategic orientation of their company or business unit. The investigation, if the academic degree has an influence on the response behavior of participants is carried out by another T-Test, cf. ***Table 3***. As the academic degree varies between Diploma, Master and PHD within this study we introduce two groups for the following calculation: Engineers holding a doctorate (Group 1) and engineers holding a master or diploma degree (Group 2).

Table 3: The influence of the academic degree on competency demands of employees – results of an inquiry (Extract)

		N	Average	Standard deviation	F	Significance	Sig. (2-sides)	Average difference	Standard error of the difference	95% confidential interval	
										minimum	maximum
K14	1,0	43	2,84	0,998	0,232	0,631	0,033	0,487	0,225	0,04	0,935
	2,0	40	2,35	1,051			0,034	0,487	0,225	0,039	0,936

According to the findings of the calculation, the response behavior only differs significantly for K 14 *to be able to estimate consequences of a new standard or specific content within a standard*. As the majority of employees holding a PHD has a management position, this result could have been expected.

5.3.4 Practical knowledge of an employee

Practical knowledge is defined as knowledge gained and used in practical application. It's highly personalized, context-sensitive and situation-specific (Porschen, 2008). Employees disposing over this specific type of knowledge can be described as experts. According to (Dreyfus & Dreyfus, 1987) they don't solve problems or make decisions; they just do whatever is working as long as no exceptional problems occur.

One main result of our interview study is that the whole area of standard application heavily relies on practical knowledge of particular employees - especially to examine customer specifications and to evaluate if required standards are relevant for the own product or process. In a few companies experts are seen as a consultant who supports their business unit to handle these tasks instead of implementing standards by themselves. In product development these are normally senior engineers with a high degree of practical knowledge concerning the own product and relevant standards. Another field heavily relying on practical knowledge is the field of standardization- a fact which has been examined in detail within the state of the art, e.g. (Feuchter, 1996), (Jakobs, et al., 2001). Hence practical knowledge is essential in the whole area of standardization; within standard setting as well as standard application. Consequently the required competency demands in the field of standardization might differ depending on professional experience.

To investigate if the practical knowledge influences the respond behavior, the participants of the study can be divided in 4 groups by their years of graduation:

- Between 2010 and 2015 (group 1)
- Between 2005 and 2009 (group 2)
- Between 2000 and 2004 (group 3)
- Before 2000 (group 4)

Using a multivariate variance analysis lead to the following results:

Table 4: The influence of practical knowledge on competency demands of employees – results of an inquiry (Extract)

					Allover average		
	F	Sig.	Partial Eta-square	Average		95%- confidential interval	
						Minimum	Maximum
K2	2,851	0,045	0,123	2,666	0,119	2,428	2,903
K4	2,96	0,039	0,127	2,354	0,132	2,091	2,618
K5	3,127	0,032	0,133	2,006	0,125	1,757	2,255
K13	2,737	0,051	0,119	2,377	0,124	2,129	2,625
K14	2,493	0,068	0,109	2,664	0,135	2,394	2,933
K15	3,519	0,02	0,148	1,694	0,137	1,42	1,968

According to our calculation the year of graduation has a significant influence on the variables K2, K4, K5 und K15, whereas K13 und K14 are marginal significant. It's notable that especially non-application-oriented competencies depend on professional experience. Information about the direction of the influence can be taken of the descriptive data:

Table 5: Descriptive data for the calculation "significance of practical knowledge"

Descriptive Statistics				
		Average	**Standard Deviation**	**N**
K2	1	2,29	0,784	21
	2	2,47	1,02	19
	3	2,78	0,833	9
	4	3,13	0,957	16
	Allover	2,62	0,947	65
K4	1	2,1	0,944	21
	2	2,21	1,084	19
	3	2,11	1,054	9
	4	3	0,966	16
	Allover	2,35	1,052	65
K5	1	1,62	0,865	21
	2	1,84	0,898	19
	3	2	0,707	9
	4	2,56	1,209	16
	Allover	1,97	1	65

K15	1	1,81	1,167	21
	2	1,37	0,684	19
	3	1,22	0,667	9
	4	2,37	1,36	16
	Allover	1,74	1,108	65

Hereinafter possible explanations for the results will be discussed:

1.) To know basic terms in the field of standardization (K2)

According to the descriptive data, the relevance increase with increasing professional experience. As mentioned in chapter 5.1 this competency is evaluated as low important as it don't offer added value considered in isolation. Nevertheless it is seen as quiet important implicit knowledge. Implicit knowledge is characterized as partially formalisable, linked to an action, tacit and in general subjective (Wais, 2006), which is mostly acquired by doing (Bodrow & Bergmann, 2003). However, explicit knowledge is objective and multipliable, leading to the aim of each company to transfer implicit in explicit knowledge (Bodrow & Bergmann, 2003). Consequently we propose following explanation, which needs to be investigated in further research: Young professionals are applying standards without being aware of necessary background knowledge. This awareness increases with professional experience. Especially standard setters, mostly belonging to group 4, develop an awareness of the necessity of basic terms, as they need to use them frequently in committee work.

2.) To know the international committee landscape (K4)

The average values of group 1-3 are nearly similar, whereas the average of group 4 is significantly higher. This group shows an above-average commitment within standard setting; after all 63% of these participants are presently active in committees. As shown in chapter 5.2.2 this competency is evaluated significantly more important for standard setters. Furthermore the results of the interviews as well as state of the art show that companies are represented in standardization by employees with strong professional background.

3.) To know the formation process of standards (K5)

The relevance of this competency increases with progressive professional experience continuously. It is more significant for people involved in committee work, whereas the overall average is lower.

4.) To be able to write a standard (K15)

Unlike the results for K4 and K5 this competency is most relevant for senior employees but quite important for young professionals as well. The importance from a senior's perspective can be explained by their activity in committee work. According to the interviewees lots of companies develop company standards, process-, design- and procedural instructions on behalf of the management or motivated by personal initiative. Additionally the majority of the interviewed companies indicate that all these activities are running beside day-to-day business. As a consequence especially young professionals who are not strongly involved project work handle this task. This observation could be a possible explanation, which needs to be proved in further research.

6 Conclusion

Necessary elementary competencies of an employee in standardization and their connections in a hierarchical way are described in a competency model by means of competency dimensions. According to the results of this paper the developed competency model is suitable to describe demands of engineers in the field of standardization. All formulated competencies are evaluated within a first quantitative study by a group of product developers. As the majority of employees implement standards in daily work instead of creating them, application-oriented competencies are evaluated higher generally. Concerning main influencing factors on particular demands it can be shown for our samples that:

1.) Not-application oriented competencies are getting more important with increasing professional experience.
2.) The ability "*to be able to estimate consequences of a new standard or specific content within a standard*" is related to the academic degree of an employee. Its relevance increases with the higher the degree.
3.) The competency "*to be able to research standards*" is more important for SME's than for large-scale companies.
4.) Employees involved in standard setting evaluate the competencies "*Reasons why companies use/rely on standards"* and "*Knowledge of national or international standardization organizations*" is higher relevant.

The quantitative study has been carried out by graduates from one university. Thus the sample is quite small compared to number of engineers in German industry. Most of the participants hold a degree in mechanical engineering with a major subject in product development. Therefore their profile is quite similar. This allows comparing the participants to each other, but the sample doesn't represent all mechanical engineers of different universities with different major subjects across Germany simultaneously. To be able to make generally valid statements, this study can be seen as a pre-study and needs to be extended to larger sample including different universities and subjects within engineering sciences.

Against the background of the state of the art, it can be concluded that a stronger focus needs to be set on standard application to prepare students for future tasks within the company. The developed competency model offers a base for a competency-oriented development of such a curriculum for engineers consisting of different modules. Subsequently these modules need to be defined in detail, not only for higher education but also for specific trainings on job. As the state of the art provides already a variety of different proposals for lecture contents these could be used to extend the model.

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Macro Drivers of Coopetition The Convergence Process of the IFRSs and the US GAAPs

Anne-Sophie Fernandez & Françoise Pierrot

University of Montpellier – Montpellier Research in Management

francoise.pierrot|Anne-Sophie.fernandez@umontpellier.fr

Abstract: *Coopetition is a paradoxical strategy combining simultaneously cooperation and competition. The reasons why actors adopt such paradoxical relationships remains under-investigated. Previous scholars focused their attention on the analysis of a single driver at one level of analysis. Scholars agree on the necessity to study multiple drivers at the same time to understand the phenomenon. However, a very few studies are dedicated to this question. Our research aims to fill this gap. We wonder what the macro drivers of coopetition strategies are. To provide insights on these questions, we conducted a longitudinal case study of coopetition strategies between two institutions the FASB and the IASB in the specific context of the global accounting standard-setting process and more particularly the convergence process between the US GAAPs and the IFRSs. Our findings enable us to identify three different phases in the process. We provide evidence on the role of the third-party (the European Union in the case) in the management of the tension between value creation and value appropriation.The involvement of the third-party encouraged the value creation phase. Its actions modified the value appropriation process. Partners did not obtain an equal value. Our findings evidence economic, structural and institutional drivers. They also insist on the key role of the third-party in coopetition dynamics.*

Keywords: *Accounting standard setting, coopetition, macro drivers*

1 Introduction

The past global economic crisis highlighted the impact of the accounting standards on the evaluation of firm performance. In such a context, the type of standards companies use became increasingly critical. Both the FASB[1] and the IASB[2] are two of the most important standard-setting bodies, responsible for accounting standardization in the world, each one developing its own set of standards: the US GAAPs[3] and the IFRSs[4]. The economic and financial globalization pointed out the need for global accounting standards. As an answer to this issue those institutions, previously acting as competitors, began to collaborate and worked on a convergence project in order to develop a single set of high quality global accounting standards. From a strategic point of view, this evolution is analysed as coopetition, defined as simultaneous competition and collaboration (Brandenburger and Nalebuff, 1996).

Combining two opposite logics such as collaboration and competition in coopetition strategies represents a paradoxical situation in which multiple tensions arise (Gnyawali et al., 2008; Gnyawali and Park, 2011). Firms adopt coopetition strategies in order to increase together the size of the pie through collaboration, while they expect to obtain a bigger piece of pie than their competitor. Previous scholars paid attention to drivers of coopetition. They identified

[1] Financial Accounting Standard Board

2 International Accounting Standard Board

[3] United-States General Accepted Accounting Principles

[4] International Financial Reporting Standards

external and internal drivers of these strategies. However, previous studies remained focused on a single driver at a specific level of analysis: industry, firm, individual. As pointed out by Gnyawali and Park (2009), it is necessary to investigate simultaneously multiple drivers to understand the emergence of coopetition strategies. In the coopetition literature, macro drivers are little explored. Nevertheless, these drivers are essential to understand why MNF[5] or institutions adopt paradoxical strategies such as coopetition.

Thus, our research aims to answer the following question: what are the macro drivers of coopetition strategies?

In order to provide insights on this question, we conducted a longitudinal in-depth case study of coopetition relationships between two main accounting standard-setters the FASB and the IASB. The longitudinal study allows us to highlight the macro drivers of coopetition strategies over time. Developing global accounting standards useful for worldwide companies is a challenging and competitive activity that led two important standard-setters to collaborate, whereas they remained competitors to some extent. While most of previous studies focused their attention on worldwide companies (Gnyawali and Park, 2011; Fernandez et al., 2014) or between SMEs[6] (Gnyawali and Park, 2009), in this study we show that institutions represent relevant and appropriate empirical background to investigate coopetition strategies.

Our findings confirmed that coopetition strategies between institutions are driven by multiple macro drivers. In line with previous studies, we confirmed the important role of economic, structural and institutional drivers. We also evidenced the key role of the third-party in coopetition dynamics.

2 Theoretical framework

2.1 Coopetition, a paradoxical strategy

In strategic management, competition and cooperation have often been presented as two opposing forces. Bresser and Harl (1986) show that sequences between cooperative and competitive strategies creates many dysfunctions. Several authors consider that it may be beneficial for companies to combine competition and cooperation, two strategies that were previously thought to be *a priori* contradictory (Bengtsson and Kock, 1999, 2000; Brandenburger and Nalebuff, 1995, 1996). The creation of the neologism ‘coopetition’, a contraction of cooperation and competition, gives rise to a new research field, which analyses relationships that are simultaneously cooperative and competitive. Brandenburger and Nalebuff (1995, 1996) are the first authors to propose a framework of coopetition. They use game theory to define the coopetition as “a bringing together of interests between complementors when cooperation and competition occur simultaneously” (Dagnino et al., 2007, p. 88). More recently, Bengtsson and Kock (1999, 2000) develop a theory of coopetition based mainly on the social network analysis and the resource based view (RBV). The authors define coopetition as a “dyadic and paradoxical relationship which emerges when two companies cooperate in some activities, and are at the same time in competition one with the other on other activities” (Bengtsson and Kock, 2000, p. 412). This definition of the concept is the most relevant.

[5] Multi National firms

[6] Small and Medium-sized Enterprises

Coopetitive strategies have been increasing over the years with expanded managerial significance. The diffusion of coopetition goes beyond multinational firms. Indeed, coopetition becomes a real strategic standard between SMEs (Morris et al., 2007; Gnyawali and Park, 2009), between subsidiaries (Luo, 2007) but also between institutions. Too less attention has been paid to coopetition between institutions, creating a gap on the literature about coopetition. This research is focused on the strategic decision-making process of institutions. The objective is to understand why competing institutions are involved in such paradoxical relationships. In order to do so, we explore the literature about the drivers of coopetition.

2.2 Drivers of coopetition strategies

Among the multiple drivers of coopetition drivers, a distinction between external and internal drivers seems relevant.

External drivers refer to the factors encouraging the emergence of coopetition strategies between companies in a specific industry. At the industry level, the importance of technology, the intensity of R&D costs, the shortening of product life cycles explain why competitors need to collaborated with each other (Bonel and Rocco, 2007; Gnyawali and Park, 2009). These external factors lead to deliberate coopetition strategies. But, coopetition strategies can also result from other external factors, such as the action of a third- party (Jacobides et al., 2006). Third-parties contribute to the development of "coopetitive" ecosystems (Gueguen, 2009). Governments, institutions or even clients (Rusko, 2011) can force competing firms to collaborate in certain markets (Ancarani and Costabile, 2010; Depeyre and Dumez, 2007, 2010). The objective of public third-parties is to stimulate some industry while the objective of private third-parties is more to get the best offer from competing suppliers.

Coopetition strategies are also driven by internal factors. Internal factors have been explored from a resource perspective. Because firms have limited resources, they accept collaborations with multiple partners (Jorde and Teece, 1990). They aim to combine complementary resources in order to create new ones. Complementarities are more important between competitors. Thus, collaborate with a competitor appears as a rationale choice to benefit from similar and complementary resources. Indeed, coopetition provides access to resources held by other firms (Lado et al., 1997; Bengtsson and Kock, 1999, 2000). The cooperation provides the missing resources, but the maintenance of competition keeps the level of innovation necessary for the survival of the firm on the market. Finally, coopetition strategies can be driven by a learning strategic intent. Firms expect to learn from their partner through the collaboration. For the firm, the objective is to reduce its weaknesses in order to be more competitive in future or other markets (Baumard, 2010). When the learning process is the only objective of the firm, its "hidden agenda" (Hamel, 1991), tensions appear in the coopetition relationship. These critical tensions require specific managerial tools to be handled (Fernandez et al., 2014).

External drivers and internal drivers are not mutually exclusive. The theoretical model of Gnyawali and Park (2009) shows that a combination of several drivers (external and internal) explains the emergence of coopetition strategies between SMEs (figure 1).

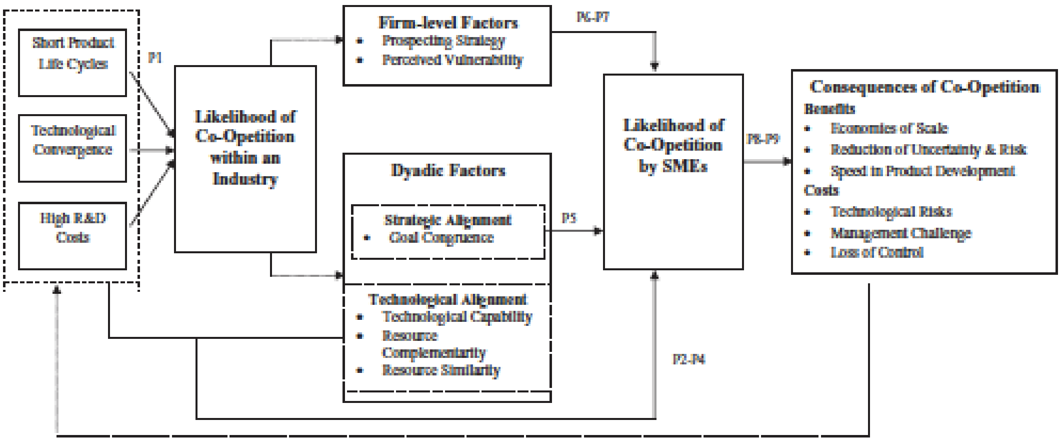

Figure 1. Drivers of coopetition strategies between SMEs

2.3 The literature gap: macro-drivers of coopetition strategies

Actors do not have the same propensity to develop coopetition (Bengtsson and Kock, 1999, 2000; Gnyawali and Park, 2009). Some of them focus their attention on coopetition while others deliberately refuse to work with their competitors (Gnyawali and Park, 2009). The reasons for this choice are not well understood. Scholars tried to explain the adoption of coopetitive strategies by examining several levels of drivers: industry, dyadic, organization and intra-organization. But, the complexity of coopetition cannot be summarized at a single level of analysis. In order to understand why institutions adopt coopetition, we try to develop a framework about macro drivers of coopetition.

Coopetition is more likely to emerge in dynamic and complex environments in which knowledge is the core of firm's competitiveness (Carayannis and Alexander, 1999). Though, coopetition appears mostly in high-tech industries (Gnyawali et al., 2008). Three characteristics of high-tech industries explain why coopetition become a strategic standard: The short life-product cycle, the technological convergence and the importance of R&D costs (Gnyawali and Park, 2009).

Michael Porter (1980) considers that the structure and the environment influence inter-organizational competitive behaviours. The same logic can be applied to coopetition: the structure and the environment influence inter-organizational coopetitive behaviours. Okura (2007) show that coopetition emerges because a specific structure exists to allow the actors to achieve common objectives on some activities and private objectives on other activities. Moreover, the markets' structures can encourage cooperation or competition. They also pressure the way in which both strategies combine one with the other. The edition of formal rules, like the Sherman Act in 1890[7], drives the strategic choices of the actors. Institutions have the power to influence the structure of the market and thus to induce coopetition (Bonel and Rocco, 2007).

The structure of a network is also powerful to stimulate collaboration between competitors (Ring and Van de Ven, 1992; Easton and Araujo, 1992; Gomes-Casseres, 1994). In clusters, collaboration between competitors is critical for the innovation process (Bengtsson and Solvell, 2004). The Silicon Valley is a good example of potential coopetitive structure (Ferrarry, 2003).

[7] The Sherman Act is an Antitrust Law or Competition passed by Congress in 1890

The dyadic relationship could be direct (without being mediated by a third party such as a client, consultant, government or institution) or mediated by such a third party (Jacobides and Billinger, 2006). Previous researches show that the presence of a third actor, who is not a competitor, provides interesting dynamics coopetition. Depeyre and Dumez (2010) compared the role of a third actor to an architect in terms of designing and driving coopetition. Castaldo et al. (2010) point out that the intermediary impacts not only the emergence of coopetition but also the management of the relationship.

Globalization increases hypercompetition (D'Aveni, 1995) and created new collaborative opportunities (Contractor and Lorange, 1998). In spite of being competitors, actors have to face the same environmental constraints. In such a context, pooling their forces appears as a good opportunity to survive maintaining their market shares (Tidstrom and Ahman, 2006; Bonel and Rocco, 2007). Two competitors can also decide to cooperate in order to win against a third common competitor (Bengtsson and Kock, 1999).

The diffusion of coopetition like a strategic standard is surprising. The neo-institutional theory explains the phenomenon by the presence of a common institutional environment (Meyer and Rowan, 1977). This perspective offers interesting insights to understand the emergence of coopetition (Oliver, 1991). Coopetition can result from three types of isomorphic institutional pressures (Di Maggio and Powell, 1983; Scott, 1995). First, coercive isomorphism comes from political influence. An actor can formally or informally pressure actors to fit with cultural standards of the society. These pressures can be seen as incentives by the actors to join the collusion. In that sense, coercive isomorphism influences coopetition. Second, mimetic isomorphism explains the diffusion of coopetitive practices within an industry (Luo, 2004) or in high-tech industries (Gnyawali and al., 2008). The adoption of coopetitive strategies result from the actors' will to be consistent with environmental norms and standards. Third, normative isomorphism is related to the professionalization of the labour force and has less power to explain the emergence of coopetition than the two other types of isomorphism.

The above literature review above offers interesting insights to understand macro drivers of coopetition. Based on the different drivers identified, we propose the following integrated framework (figure 2). This framework will be discussed with the results of our case study.

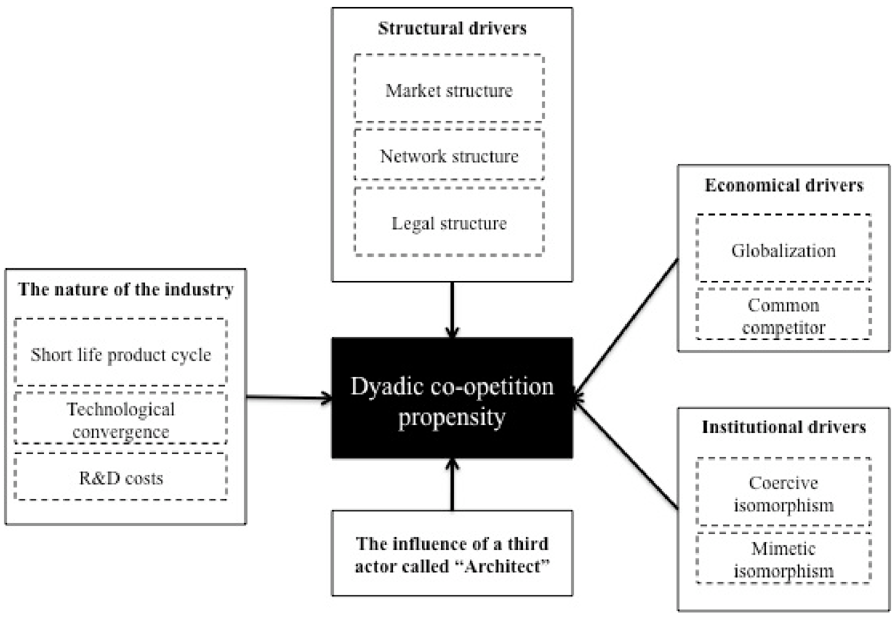

Figure 2: Theoretical framework of macro drivers of coopetition strategies

3 Method

3.1 Research Design

Case-based exploratory methods seem very appropriate to understand a phenomenon that is poorly understood (Eisenhardt, 1989). Because in-depth study explores and details a multi-faceted subject, they are the best way to analyze paradoxical phenomenon such as coopetition (Bengtsson et al., 2010). Accordingly, we conducted in-depth study of an exemplar case of coopetition in order to develop insights about the evolution of the phenomenon and the factors influencing this phenomenon (Yin, 2003). Since our aim is to point out the influence of the third party in a coopetition process, a longitudinal analysis appears relevant (Pettigrew, 1990).

We designed this research as an exploratory study to generate insights about the role of the third party in the management of the tension between value creation and value appropriation. Relationships between the FASB and the IASB were initially competitive to set the global accounting standards. The accounting harmonization process encouraged both organizations to collaborate, to create a single set of global accounting standards. Thus relationships between both institutions represented an interesting case of coopetition strategy. In this case, coopetition was not a balanced relationship. So far, the process was dominated and leaded by the FASB. The American institution was confident about its own set of standards - the US GAAPs – and its capacity to become the international standard. The IASB was challenging the FASB that was promoting another set of accounting standards. The involvement of the European Union (UE) in 2002 represented a major shift in the situation. The UE adopted the IAS/IFRSs standards instead of the US GAAPs. This decision disturbed the structure of the partnership between the FASB and the IASB in favor of the IASB.

The accounting standards harmonization process represents an exemplar case of coopetition influenced by a third party. The longitudinal study allowed us to investigate the evolution of the balance of power between coopetitors and the important impact of the third party on it.

3.2 The accounting standards harmonization process

Accounting reports aims at giving information to companies' stakeholders on value creation resulting from resources consumption and products or service production. Financial information production and distribution influence the value creation and allocation in the sense it is used in contracts formation and transactions (Charreaux, 2009).

In 1980, Burchell et al. described accounting as functioning as a cohesive and influential mechanism for economic and social management (Burchell et al., 1980). This assertion is even truer nowadays when more and more companies finance their development through capital markets where investors mainly use this information to make their investment decision. Depending on the referred accounting standards, the information content may vary and also the investors' decisions.

During the last century, the main industrial countries develop their own accounting standards in order to help companies to report their financial information in priority whether to investors or to the tax authorities and creditors, depending on the accounting model they refer to: the Anglo-Saxon or the Continental one (Nobes, 1983). At this time, Nobes dissociated the "Macro-Uniform Government-driven Tax-dominated" from the "Micro-fair-judgmental commercially-driven" approach. Depending on the country, accounting regulation is assumed by the State or some inter State organization (the case of the EU), or by an independent entity like the FASB (the case of the USA: although considered as independent, the FASB is controlled by the SEC) or a totally private independent organization like the IASB. "Accounting standards are the result from a complex interaction among numerous parties"

(Watts and Zimmerman, 1978, p.112) and, depending on the parties involved the standards content may vary also (Boström and Tamm Hallström, 2013).

The form of accounting regulation is contingent to each country, depending on historical, social, economic, legal and political features (Colasse, 2005). These contingencies led to the elaboration of different accounting languages almost in every country. These differences interferes with the understandability and comparability of financial information beyond borders and consequently with the access of public companies to foreign capital markets. Accounting standards, as the language of business, became an important actor of the development of International companies.

At a European level, the EU decided to enter into an accounting harmonization process by developing the 4th, the 7th and the 8th directives (1978, 1983, and 1984) to narrow the differences and improve the comprehension of accounting information between the European countries. In the 90's, the EU did not succeed in harmonizing the accounting practices throughout its territory, and European companies began to use the US or the international accounting standards to reach information comparability on capital markets (Higgins and Tamm Hallström, 2007). The US GAAPs were considered as the best accounting system and most companies used them in order to achieve understandability and comparability of their financial statements among international investors. The IASs were developed by the International Accounting Standards Committee (IASC), a private organization created in 1973 by some of the main accounting professional associations coming from nine countries[8].

Since the creation of the IASC by Henri Benson in 1973, the need for accounting standards harmonization led the FASB and the IASB to cooperate in order to reach a consensus on specific themes (Street and Shaughnessy, 1998). In 1993, the FASB was one of the four Anglo-Saxon standards setters (with the Australian Accounting Standards Board (AASB), Canadian Accounting Standards Board (AcSB), FASB and UK Accounting Standards Board (ASB)) the IASC began to work with in order to achieve accounting compatibility between their standards. At the same time, the accounting standards of the FASB and the IASC were competing in the harmonization process conducted in Europe (Colasse, 2004).

In the late 90's, the question of the choice of one of those sets of standards emerged for the EU. In 2000 the International Organization of Securities Commissions (IOSCO) recognizes the IASs as a qualitative set of accounting standards. In 2002 the EU decided to adopt the IASs as European accounting standards, and therefore avoid the USA hegemony in terms of accounting standardization (Chiapello, 2005). Relationships between the FASB and the IASB have evolved since then and ended up at a common project of accounting standards convergence: the Norwalk agreement (2002). This agreement leads to interdependencies between them as they work together on the development of high quality accounting standards for worldwide companies listed on capital markets. From 1st January 2005, the IASs became mandatory for the consolidated accounts of around 6000 European listed companies.

The EU decision to choose the IAS/IFRSs instead of the US GAAPs, allowed the IASB to improve its legitimacy and spread out its standards all over the world.

3.3 Data collection and analysis

We intentionally carried out a qualitative case study method, as this method would enable us to avoid the constraints of a preliminary choice of tools or types of data to be used (Yin, 2003), making it possible to access heterogeneous data collected from a variety of sources

[8] Australia, Canada, France, Germany, Japan, Mexico, Nederland, United Kingdom and Ireland (considered as one country) and the United States of America.

(Langley & Royer, 2006). Moreover, this method makes it possible to analyze the evolution of a phenomenon over time (Eisenhardt, 1989; Pettigrew, 1990). Following the criteria for qualitative analysis (Eisenhardt, 1989; Yin, 1994; Eisenhardt and Graebner, 2007) we began our case study analysis by interviewing seven individuals involved in the convergence process, either directly as active members of their institutions or as highly skilled observers. We conducted semi-structured interviews as they enable us to keep in mind the general research questions regarding coopetition process and they allow constructs to surface freely regarding the evolution of the phenomenon and the influence of the third party (Glaser and Straus, 1967). Based on this round of interviews, we have been able to identify different phases in the accounting harmonization process corresponding to different phases in the coopetition strategic process. These interviews helped us to understand the critical implications of the involvement of a third party in the process.

In total, we conducted seven semi-structured interviews lasting about 60 minutes each. Because of the geographical distance, we conducted conference calls individually. All interviews have been recorded and then transcribed as soon as possible to preserve the quality of information. Interviews were performed in French, except for one in English. Table 1 provides more details about the distribution of interviewed participants.

Table 1. Distribution of interviews participants

Interviewee number	Institution	Location	Interview duration
1	Autorité des Normes Comptables[9] (ANC)	Paris (France)	62’
2	BRUEGEL	Brussels (Belgium)	25’
3	European Financial Reporting Advisory Group (EFRAG)	Brussels (Belgium)	51’
4	International Accounting Standards Board (IASB)	London (Great-Britain)	49’
5	IFRS Foundation	London (Great-Britain)	87’
6	IFRS Advisory Council	London (Great-Britain)	53’
7	World Accounting Report/IFRS monitor	London (Great-Britain)	75’

Consistently with our aim to investigate the process over time, a longitudinal analysis was required. Following the criteria of longitudinal analysis, we collected secondary data covering the period from the end of the 90’s until now. Secondary data were gathered from multiple internal and external sources. Internal secondary data come from reports and notes written by the concerned organizations, the FASB and the IASB. External secondary data were collected from national reports, experts’ analysis, press articles and reports published online by other entities such as national standard-setters or capital market regulators. Primary data collected from interviews were confronted with secondary data in order to confirm our interpretation of the phenomenon. Internal and external sources of data reduced the influence of the vision of the FASB and the IASB, limiting the bias on our analysis.

A first round in the coding process consisted in identifying and describing the different phases of the process. Following Miles and Huberman (1994), we used another round of “interpretive” coding on the whole material gathered (primary and secondary data) to go beyond the description of the phenomenon. The interpretive codes provided additional meanings and identified some explanations of the process studied.

[9] The role of each institution is explained in the appendix

We present our findings in the next section based on the collected and analyzed information. We provide exact quotes from our interviews when appropriated to illustrate our insights. When interviews were performed in French a translation of the quotes would be provided in English. In order to preserve anonymity of our interviewed participants, we will not name them but rather refer to the interview using its number.

4 Findings

Our case study enables us to draw different phases in the coopetition process between both institutions. We try to explain the process evolution.

4.1 Before 2000's: the Beginning

The FASB and the IASC were formed the same year, in 1973. From that time to the end of the early 2000's, each board developed its own set of accounting standards: the US GAAPs (FASB) and the IASs (IASC). The first one, very sophisticated and developed was mandatory on the US capital market, the most important in the world, whereas the second one was only used by a few countries: *Until 2002, only a few countries decided to use IASC standards. Many of those were countries that lacked their own standard-setting infrastructure. (FASB's website).*

From the 70's, when the financialization of economy began to spread across internationally, the need for harmonized standards arose. This need became more important at the end of the 90's when, after the fall of Berlin Wall, big European companies decided to list on the American financial market. To achieve their goal, they had to convert their domestic standards financial statements into US GAAPs ones. Interviewee number 5 explained this process with more details:

> *Back then, euh, we witnessed the beginning of the globalization and internationalization of the markets, euh… with the need for internationally exposed big companies to go and list on foreign markets, mainly the American market at that time.* (Interviewee n°5)

By this time, European companies were authorized to use US or international standards to publish their consolidated accounts on the European capital markets but, as they were obliged to use the US GAAPs on the American markets, they chose these latter.

The US and international standards were clearly competing against each other on the European area and American companies were advantaged because they did not have to translate their financial statements to list on European financial markets. Moreover, the EU had not succeeded in its European harmonization process with the directives and was thinking about a different solution: a new set of accounting standards, but which one? As more and more European companies were adopting the US GAAPs, the FASB's standards could have been the solution as they were the most developed, renowned and legitimate. But some people began to fear the adoption of a set of national standards as international ones, and the consequences of this adoption on the standard-setting process. Quotes from interview number 5 partly insisted on the challenges of that context:

> *And the standard-setters of that time, some of them, which I was part of, got worried of this evolution saying: "it is not possible that the globalization movement is made through the adoption of a national standard, even if was it an American standard, of great quality but which, which… to the development of which other stakeholders do not take part. (Interviewee n°5).*

Finally the EU chose the international standards in the early 2000's. While competing against each other during that period of time, the FASB and the IASB started to collaborate on some subjects in order to improve comparability of financial statements, but without formal agreement. Each board developed its own strategic plan: the IASC to gain more legitimacy and the FASB to achieve *its ultimate goal of internationalization as a body of superior international accounting standards that all countries accepted as GAAP for external financial reports* (FASB website)[10].

Each board aimed at the same objective on its own pace, and sometime collaborated with each other, to finally both agree on a convergence project in order to work together on a set of high quality global accounting standards.

4.2 From 2000 to 2006: the path to convergence

The IASC's search for legitimacy was completed in the early 2000's first when the IOSCO declared the IASs were quality standards and second, when the EU decided to adopt the IAS/IFRSs as the European accounting standards. This decision was very important because, starting from 2005, around 6 000 European listed companies were required to use the IAS/IFRSs for their consolidated financial statements at least. Quote from interviewee number 7 highlighted the importance of the EU decision:

> *The Commission decided in 2000, even before the IASB exists, to do it (adoption of the IAS). This meant that there was a block of the worldwide economy, an important block of the worldwide economy that was, that adopted the IFRS, almost from the beginning. That gave a significant credibility to the IASB. (Interviewee n°7).*

For the EU, the adoption of an international set of accounting standards was another step to achieve its plan of an integrated capital market besides the adoption of the Euro and the creation of a European stock exchange (Euronext).

By the same time, the FASB and the IASB initiated a formal collaboration (the Norwalk Agreement in 2002) in order to work on the convergence of the US GAAPs and the IFRSs. Even if both institutions declared striving towards the same goal, it seems that the FASB had its own strategic agenda. Through the convergence process, the FASB was expecting an improvement of its own standards with the ambition to achieve a set of international converged standards and preserve its leadership. Interviewee number 5 provided more details about the reasons of the FASB's decision:

> *So, their starting point is not: "we are going to abandon our package to immediately jump to the international one", it is: "we support the international convergence but, as we are major players with one of the most advanced standards, we keep room for maneuver and, for both technical concerns and question of the link of the standards with our domestic environment, etc. We want to retain control over the process and engage in a long term convergence process. (Interviewee n°5).*

The adoption of the IAS/IFRSs in Europe marked the beginning of the spreading of these standards across other countries which required or converged to the IAS/IFRSs (Australia, South Africa, New-Zealand).

The accounting standards battle seemed over in Europe and the IASB won. But the war was not completely over because other major international stock exchanges were at stake: China, Japan, South America etc. and the United-States. Plus, the stake evolved from a question of standards to a question of who would set the global accounting standards. Quote from interview number 3 confirmed that the US GAAPs were no more the most internationally used accounting standards. The FASB was losing its leadership:

[10] http://www.fasb.org/jsp/FASB/Page/SectionPage&cid=1176156304264

> *…With a declaration of a senator I think, whose of course I don't remember the name, but who was saying: "ladies and gentlemen, we lost the standards battle in the sense that our GAP won't be the international standards. We still can win the standard-setter battle." And then basically, try to get a major influence within the IASB. But this goes back to 2006 so, I think that it's been a long time since in the Unites-States one understood that the US GAAP… I don't know if they dreamed about it one day honestly… But anyway, it's been a long time since they understood they lost. (Interviewee n°3).*

4.3 From 2006 until now: from convergence to a new power structure

2006 was the year of a new Memorandum of Understanding (MoU) between both standard-setters reaffirming a common set of high quality standards as their common strategic priority. A progress report followed in 2008 and a new MoU in 2010.

During this period of time, the evolution of the IFRSs was mainly influenced by the bilateral discussions between the FASB and the IASB within the convergence process, as explained by interviewee number 4:

> *So in 2006, they made an inventory of the problems and they got to work saying: "ok, why are there differences, heu… can we settle them?" Then, in one case the IASB adopted the American solution because… it seemed satisfactory. In another case the Americans adopted the international solution so there were some… some two-way exchanges etc. and each one got closer to the other one step at a time, either adoption one solution or another. (Interviewee n°4).*

This evolution led the SEC to accept IFRSs financial statements on the US capital market for foreign companies in 2007. That step represented an important evolution when remembering that at the end of the last century, the situation was the opposite: US GAAPs were authorized on European capital markets and not the opposite.

Meanwhile the number of countries requiring or authorizing the use of the IAS/IFRSs was increasing fast. The 2008 economic crisis pointed out the important role of accounting standards on capital market. Consequently in 2008, the pressure to succeed increased: *The Group of 20 Leaders (G20) called for standard-setters to re-double their efforts to complete convergence in global accounting standards.* (ifrs.org)[11].

In 2010, more than half of Global 500 companies used the IFRS, and more than 120 countries required or authorized the use of the IFRS on their domestic market. The spreading of international standards had increased to the detriment of the US GAAPs. The FASB tried to expand its participation in the governance of the IASB. But members of both institutions and the governance rules of the IASB changed. The EU played a part in the standard-setting process mainly thanks to the European Financial Reporting Advisory Group (EFRAG)[12], which could speak with the IASB in the name of the EU. Interviewee number 4 confirmed this argument:

> *…Until the arrival of the EFRAG, no, Europe had no part, because Europe didn't have a European vote….what the EFRAG succeeded in was to find a meeting place where a European view was developed….So from the time the EFRAG has got a view… it tells us, heu… "the European position is this one", heu…on the one hand, the European members of the board cannot be insensitive to this European view, even if we are not supposed to obligatory vote… accordingly with what the EFRAG thinks, but we consider it, and when we are informed of this position by the EFRAG, this position is well documented and based on serious works of consultation, analysis, we can consider it as much as what the American board members say around the table (Interviewee n°4).*

[11] http://www.ifrs.org/Use-around-the-world/Global-convergence/Convergence-with-US-GAAP/Pages/Convergence-with-US-GAAP.aspx

[12] EFRAG is a private sector body playing a role of technical advisor the EU

The FASB was just considered as other members of the IASB and did not benefit from any superior position. The convergence project was almost over considering that only a few technical points remained unsettled but the question of a global set of high quality standards prevailed.

In 2013, even if more than 120 countries required or authorized the use of IFRS on their capital market, some countries were still authorizing both standards, IFRSs and US GAAPs. The question of the SEC's decision for the US domestic markets was thus persisting.

In 2011, the IFRS Foundation published a report[13] explaining its strategy for next decade in which it declared *the goal of a single high quality globally accepted set of accounting is now within reach… Convergence may be an appropriate short-term strategy for a particular jurisdiction and may facilitate adoption over a transitional period. Convergence, however, is not a substitute for adoption.* It became clear that, on the IFRS Foundation point of view, the global standards would be the IFRSs. Within this framework, the Foundation developed new tools and partnerships to achieve its objective. In 2011, the IASB and the International Federation of Accountants (IFAC) proclaimed an agreement to deepen their collaboration in developing private and public sector accounting standards. In 2013, the Foundation formed the Accounting Standards Advisory Forum (ASAF), a new advisory body to the IASB, composed of national accounting standard-setters and regional bodies interested in global standard setting. The same year, the Foundation and the International Integrated Reporting Council (IIRI) signed a MoU to strengthen their co-operation to promote the global harmonization and clarity of reporting frameworks. Still in 2013, the Foundation and the IOSCO signed an agreement to *deepen their cooperation in support of their shared commitment to the highest standards of financial reporting globally* (ifrs.org)[14]. This year, in 2014, the Foundation and the International Valuation Standards Council signed a statement of protocol to cooperate in the study of standards for measurement of fair value in financial reporting. The creation of the ASAF and the various agreements with other international bodies clearly marked the end of the bilateral dialogue between the FASB and the IASB. Quotes from interview number 2 confirmed our purpose:

> *So today, the IASB changed its doctrine, instead of falling in with this exclusive work of converge with the United-States, as it was with the Norwalk Agreement, and successive modifications through a memorandum process, the IASB fall within the scope of a dialog, a consultative dialog with many national standard-setters within the framework of the forum which English acronym is ASAF. (Interviewee n° 2).*

> *Today the converge process is modified, as you know by the new approach the IASB chose this year, that is the creation of the ASAF, Accounting Standards Advisory Forum, which is, for the IASB, the occasion to end up its exclusive relationship with the FASB within the framework of the convergence process. So, the convergence process IFRS/US GAAP, is no more an exclusive process as it has been for ten years. (Interviewee n°2).*

This evolution led to a change in the power equilibrium between the IASB and the FASB, but also in the place the EU had in the global standard-setting process. In the 90's the FASB was the leader because its standards were used nationally and internationally. The US GAAPs were the most used accounting standards in the world, whereas the EU did not succeed in its European harmonization process. Today, thanks to the IAS/IFRSs adoption, the EU was

[13] IFRS Foundation. Report of the Trustees's Strategy Review 2011. IFRSS as the Global Standards: Setting a Strategy for the Foundation's Second Decade

[14] http://www.ifrs.org/Alerts/PressRelease/Pages/IOSCO-and-IFRS-Foundation-agree-joint-protocols-September-2013.aspx

involved in the global accounting standard-setting process and appeared as an important IFRSs user in the world in terms of market capitalization. Interviewee number 7 confirmed our interpretation of the process evolution:

> *We jumped from a situation in the 90's where there was only one accounting power which was the FASB. Than the harmonization inside Europe failed and so, in a sense there was no other comparable block in the world. Now we are in a situation where there are two blocks. The American block is less important than it was in the past of course. I would rather say that the EU is of equal importance as the one of the Americans now. But the EU doesn't dominate the accounting world now to the same extent the United-States did in the 90's. (Interviewee n° 7).*

It seems that nowadays, the critical question is not whether the US would authorize the use of the IFRSs for domestic users or not, but more, when and how would the US do it?

5 Discussion

This research investigated macro drivers of coopetition strategies. To discuss our theoretical framework, we conducted an in-depth case study of We studied longitudinally a coopetition strategy between two institutions: the FASB and the IASB. Our findings enable us to highlight three phases in the coopetition process (see Table 2).

Table 2. Coopetition dynamics between the FASB and the IASB

	Phase 1 – before 2000's Beginning	**Phase 2 – 2000 to 2006** The path to convergence	**Phase 3 – After 2006** From convergence to a new power structure
Nature of the relationship	Coopetition	Coopetition	Coopetition
Dimensions of the relationship	International competition	International competition (except for the EU)	Competition on a few markets
	Non-formal collaboration	Formal collaboration	Formal collaboration
Role of third party	None	Empowerment of the IASB	Involvement in the accounting standard-setting process (EFRAG)
Power structure	FASB >>IASB	FASB > IASB	FASB ± IASB
Tension between partners	Strong	Balanced	Low

During the first phase named "beginning", the collaboration between the FASB and the IASB was non-formal. Simultaneously, both institutions were competing against each other on international markets. The implementation of coopetition reflects the partners' will to develop something jointly. But beyond this common interest, each partner has its hidden strategic agenda. The FASB was confident about its standards. It was expecting to preserve its leading and dominating position on international markets. Its hidden agenda concerned the value appropriation. On the contrary, the IASB was considered as the outsider. It did not have much to lose. The tensions between both partners were very strong. They were trying to market their standards in order to increase their image and to influence financial markets to use one or the other. They put a lot of efforts to win market shares. At the same time, they were working together to improve their standards, to increase their value. Their collaboration aimed to create more value for standards' users.

However, the dyadic coopetition studied here cannot be considered as a balanced coopetition. The power structure between both partners was not equally distributed but rather dominated by the FASB.

During the second phase, named "the path to convergence", collaboration between the FASB and the IASB became more formal. They signed formal agreements to formalize their collaboration. The critical event during this period was the EU decision to adopt the IFRSs. First, this decision killed the competition between both set of standards on the European market. Second, it significantly increased the power and the legitimacy of the IASB. Thanks to the EU, which through the adoption of the IAS/IFRSs, became the catalyst for the worldwide use of the international standards. The EU decision contributed to manage the tension between value creation and value appropriation between the FASB and the IASB. The EU considered that a competition on the European market for value appropriation would be useless. Thus, the EU decided to promote value creation on its market. The initial asymmetry in coopetition was in favor of the FASB. The EU decision reinforced the position of the challenger, the IASB, at the expense of the FASB, the leader. The second phase was still dominated by the FASB but the IASB obtained more power thanks to the EU decision. The EU decision was driven by the convergence objective, the expectation of a higher common value creation. The EU decision seemed to benefit more to the IASB, but also to standards' users. The EU did not only act opportunistically but also in favor of standards' users.

In the third phase named "from convergence to a new power structure", the FASB and the IASB are still competing on a few markets while formally collaborating to improve the standards' quality. The tension for value appropriation was geographically resumed to a few markets. Since more and more countries adopted the IFRS standards instead of the US GAAPs, the equilibrium of the relationship has reversed in favor of the IASB. The IASB became a leader in the global accounting standard-setting process, thanks to the development of the number of countries which decided to use the IFRS in the world, but also to the diverse collaboration agreement the IFRS Foundation signed the past years. This adoption also benefitted to the EU in the role it played in the international accounting arena.

The new power structure and the FASB's lack of leadership on the international accounting standard-setting process can question the future of the relationships between the FASB and the IASB. We could wonder if this new power structure would lead to the end of the coopetition between both institutions.

Our findings provide interesting insights about the role the third-party in the coopetition process. In the case studied, the EU played the role of third party. The EU decided to adopt IFRS in order to promote value creation for standards' users. The decision of the EU was not deliberately in favour of the IASB or the FASB. The EU did not intentionally disturb the changes in the power structure of the relationship between the FABS and the IASB. The power disturbance was more an indirect consequence of the decision of the EU in favour of the IASB. However, at the difference of previous studies, partners did not entrust the third party to manage one dimension of their relationship (Bengtsson and Kock, 2000; Rindfleisch and Moorman, 2003; Madhavan et al., 2004; Castaldo et al., 2010).

Our findings shed new light on the consequences of the involvement of a third party in a coopetition process. They go further than previous studies pointing out the angelic role of the third party (Bengtsson and Kock, 2000; Rindfleisch and Moorman, 2003; Madhavan et al., 2004; Castaldo et al., 2010) or the opportunistic behavior the third party (Bae and Gargiulo, 2004; Madhavan et al., 2004; Fernandez et al., 2014). We can consider that the EU acted opportunistically consistently with previous scholars (Bae and Gargiulo, 2004; Madhavan et al., 2004; Fernandez et al., 2014), but on the contrary of these studies, the consequences of the EU opportunistic behavior was not the creation of new tensions between partners. The major consequence was a new balance between the value creation and value appropriation. The decision of the EU encouraged the FASB and the IASB to work on the standards' quality in order to create more value for standards' users. The decision of the EU to adopt IFRS was a signal to stop competition in the European market.

6 Conclusion

Coopetition strategies are paradoxical relationships combining simultaneously cooperation and competition (Brandenburger and Nalebuff, 1996). The reasons why actors decide to adopt such paradoxical strategies remain not well understood. Coopetition strategies are driven by multiple factors. However, previous scholars stood focused on the analysis of one single driver at one level of analysis. Even if scholars recognized the need for an integrated framework of coopetition drivers, a very few studies provided such lecture (Gnyawali and Park, 2009). Our research aims to investigate the macro drivers of coopetition strategies. We paid a specific attention to the coopetition strategies between the FABS and the IASB in the specific context of the accounting standards harmonization process. We investigated the coopetition relationship since the beginning, before the 2000's until now. Our findings enable us to identify three different phases in the process and contribute to the progress of coopetition theory.

Our first contribution is to study a coopetition process from its beginning until now. Second, we provide illustration of different macro drivers of coopetition strategies (economic, structural and institutional drivers). Third, we deeper analyse the role of the third-party in coopetition dynamics. While in other studies, the third party is expecting to equally balance the relationship between coopetitors or to disturb it at the expense of both partners, in the case, we show that the third party's action benefitted to one partner: the IASB at the expense of the FASB. This result shows that coopetition is not always a symmetric and stable relationship. On the contrary, we show that coopetition can be *per se* asymmetric, dominated by one partner. The involvement of a third party can disturb this asymmetry and reverse the power structure in favour of the challenger and at the expense of the leader. The longitudinal study enables to assume that coopetition strategies are not stable over time. By now, the status of the accounting standards harmonization process could be considered as the end of coopetition. Coopetition strategies would thus be temporary strategies between the FASB and the IASB.

Our case study suffers from limitations that offer opportunities for future research. Based on a single case, our findings are empirically embedded. If the relationship between the FASB and the IASB can be considered as an exemplar case of coopetition between institutions, similar findings could be expected in similar situations (coopetition worldwide companies, SME's, non-profit organizations etc.).

Thus, accounting standard development may be perceived as a kind of economic policy that offer the concerned standard setting organizations a sort of political power (Veron, 2007). The question of the power of standard setting organizations appears as a complementary issue that would be worth to be developed, whereas the institutions point out the interest of stakeholders and more specifically the one of investors as the main goal of their action - "efficient allocation of capital by investors everywhere in the world" (Shapiro, 2011). This may represent another way to look deeper into this fascinating subject.

7 References

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Appendix

ANC: Autorité des Normes Comptables is the French accounting standard setting organization

EFRAG: European Financial Reporting Advisory Group is a private sector body that provides input into the development of IFRS issued by the IASB and provides the European Commission with technical expertise and advice on accounting matters.

IASB: International Accounting Standards Board is the international accounting standard setter

IFRS Foundation: this foundation is responsible for governance and oversight of the IASB

IFRS Advisory Council: is the formal advisory body to the IASB and the Trustees of the IFRS Foundation

WAR: World Accounting Report is a review that offers authoritative news and analysis of the activities of standard setters, regulators and professional accounting bodies around the world

IFRS Monitor: is an electronic reporting service (International Standard-setting Report) which provides subscribers with a detailed analysis of the proceedings of the International Accounting Standards Board (IASB)

Analysing Difficulties in the Adoption of e-Business Standards, a Look from the User Perspective

Nicola Gessa, Piero De Sabbata, Arianna Brutti

DTE-SEN-CROSS, ENEA Bologna

nicola.gessa@enea.it, piero.desabbata@enea.it, arianna.brutti@enea.it

***Abstract**: In any industry sector or human activity standards definition and adoption can be one of the main mechanism to enable interoperability among applications, systems, software, services etc. Although interoperability is a key to improve communication, business, efficiency, many issues and problems make adoption of standards difficult and hard for many subjects. Considering our previous experiences in European projects and limiting our analysis to e-business standards, we deepen in this paper the problem taking the point of view of the software houses that support SMEs with ICT solution development and implement standard-based interoperability solutions. Our aim is to highlight their perspective and to find which are the main aspects of e-business standard specifications that they find unsatisfactory and hamper the standards adoption.*

***Keywords:** standard, interoperability, e-business.*

1 Introduction

Globalization is now demanding more and more communication skills, in every sense and in every field, especially in activities related with e-business, where efficient data exchange and interoperability among software systems are becoming more and more crucial. A key point in achieving this target may be the adoption of appropriate communication standards together with ICT technologies. Aim of this paper is to take the perspective of the software houses that implement interoperable solutions, trying to individuate some aspects of the standards that have a negative impact on the adoption by the developers; to do this we prepared and proposed to the software houses a questionnaire.

The structure of the paper is as follows: in section 2 we very briefly report our context, together with some aspects and problems in standard adoption; in section 3 we describe our approach in the definition of the questionnaire, its structure and how we proposed it to the software houses; section 4 presents the results we obtained, with several considerations about them; in section 5 we summarize some conclusions about the results and this experience.

2 The problem of standard adoption in e-business

Data exchange in e-business transactions is a well-known problem that has been faced in many ways all along the literature. The activities in this field has led also to the rise of the concept of "Interoperability", that has spread a lot over the last 15 years. Although differences could be in the various definitions of interoperability, all of them highlight the multi-dimensional character of the concept. Facing the problem of system interoperability in e-business means to face it on various fields and contexts: syntactic, semantic, technical, but also legislative, organizational.

Many different approaches have been prefigured to solve the interoperability problem (Chen 2006), many of these approaches have been developed and experienced inside European research projects and initiatives: IDEAS (2003), ATHENA (2007), INTEROP (2007), COIN (2011), FIA (2014), FIWARE and many others). One of these is the “Integrated approach”, (other approaches are the Unified and the Federated ones), and it is based on the use of a common specification shared between all the partners that have to become interoperable. Quite obviously, the “Integrated approach” includes the adoption of standardized interfaces and data formats to allow a seamless data exchange among partners involved in the communication. Then, on one hand standard definition and adoption is recognized as one of the best (and natural) way to allow and implement seamless data exchange between business partners; on the other hand, standardization has had different results in terms of adoption as a solution for interoperability problems. The different results depend on various factors: the characteristics of the business domain, the dimension of the industry and of the companies, the presence of wide adopted (proprietary) solutions, the type and level of communication and interoperability required.

The e-Business W@tch initiative (that has been archived on 17-2-2011) studied the impact of ICT and e-business on enterprises, industries and the economy in general and has published in the past some reports in order to draw and analyze the situation about standard adoption in different sectors. The (e-Business W@tch 2005) was focused on the application and adoption of e-business interoperability and standards (where EDI and XML are the reference technologies) in a set of 10 different business sectors and considering enterprises of different sizes (micro, small, medium and large). It was clear that especially micro, small and medium enterprises (but also bigger ones) have many difficulties in the adoption of the standards as a solution for interoperability problems. (e-Business W@tch 2008) highlighted that in the Furniture sector “the adoption of standards is very limited”: only 8% of companies adopted EDI-based standards, and 9% used XML-based standards. The same report says that “this situation is common to other manufacturing sectors where most players are SMEs and both manufacturers and distributors are fragmented”. The fragmentation poses many issues and challenges for the adoption of standards, and for the companies it is hard to find the economic justification for the necessary interventions; a similar report regarded the eHealth sector (e-Business W@tch June 2008). Anyway, it seems to be difficult to have clear and up to date statistics about adoption in so many different industry contexts.

The EU recognized the importance to push for standard adoption into European initiatives, industries, communities: (Technopolis Group 2013) evaluated, during 2013 on behalf of CEN and CENELC, the contribution of standardization to innovation in European funded research projects. It has estimated that a very significant proportion of FP6 and FP7 projects, almost one third, addressed standardization in some way (i.e. using standards as an input to the research, proposing new or revised standards based on research findings, contributing to the development of new or revised standards). Furthermore the study has established that "FP projects addressing standardization have gained a wide range of benefits as a result, and that significant impacts on innovation have already been achieved or are expected in the future" and that "in half of the cases where standardization has not been addressed this is because standards are not considered relevant to the field of research in which the project is focused".

A wide effort has been done to understand which characteristics of the enterprises influence standard adoption. (Nurmilaakso 2008) analyzes the relationships between technological/organizational factors and the use of standardized data of a company with the adoption of business frameworks, e-business functions for SCM integration and management, and migration towards XML-based e-business frameworks. Nevertheless, the paper is focused on the aspects of the company, not on the characteristics of the standards (see also Windrum 2002). (Clements 2005) analyzes the economic scenarios and the motivations that may cause the transition from an old standard to a new one, but still the focus is not on standard characteristics, but on market opportunities, company/network structure and economic considerations.

The aforementioned scenario concerns those who wonder “which are the conditions or the limits of an enterprise that hinder the adoption of standards?”, while others are wondering “which are the defects, the lacks and the deficiencies of the standards definition process and specification that make difficult standards comprehension/adoption from the enterprises?”. The relevance of improving communication means and data exchange capabilities between the industry, the services, the public administrations is well recognized in the European Union(EC 2014), that strongly demands for definition and adoption of standards and incentives standard based solutions to solve interoperability problems. EU tries to modernize its ICT standardization policy, and to define the key aspects and the attributes for this modernization (strongly requiring a synergy between research, innovation and standardization) (EC 2009), where “quality” (of standard) is one of the keyword, and also solicits the acceleration and simplification of the procedures for standardization (EC 2011).

(Sherif et al. 2007) highlights both the difficulty of defining what is the “quality” of a standard (that is often subjective), and the need to define a way to evaluate it, also considering the wide number of stakeholders involved in the standardization process. The paper briefly discusses some approaches (based on the Total Quality Management (TQM) methodology) for quality measurement and evaluation, and considers instead the possibility to adopt the project management methodology to improve standard quality. Methods for standard quality evaluation are discussed also in (CAMSS).

Considering the dynamics of the diffusion and adoption of new innovations, relevant results, both in the ICT or other sectors are in (Rogers 1995), while (Davis 1989), (Venkatesh 2000) present models to analyse and understand those factors that influence user acceptance towards a technology.

Another approach to improve standard quality regards the analysis (starting often from practical experience) of the standard life-cycle, trying to identify criticalities and weaknesses in order to introduce improvements in the whole management process (Soderstrom 2004)(Brutti et al. 2012)(Hoel et al. 2012).

In this research context, and considering the various phases of the life-cycle, we want to highlight the critical factor in the adoption of e-business standards (like UBL, EDI/EANCOM, HL7, eBIZ), taking the point of view of the users: our focus is more on the perspective of the standard implementers, (or standard “consumers” as in (Sherif et al. 2007)), giving them the possibilities to express their doubts about standard specifications and to report those aspects that remain obscure, coriaceous, arduous and uphill. Our focus is on the software houses that typically support SMEs and enterprises in the standard-based solution development for data exchange and e-business. The idea is to particularly highlight the weaknesses of standard specifications, taking a new perspective and starting from the experience described in (Gessa et al. 2015) where the attempts to introduce the use of application standards in the development of software interfaces during the activities of two different European projects did not have success, missing the concrete realization.

3 The approach and the methodology for the analysis

Since our aim is to investigate the point of view of the software houses in facing the implementation of standard-based interoperability solutions and data exchange software for the enterprises, we decided to proceed elaborating a questionnaire to propose to the software houses, then to contact them asking to fill it and finally to elaborate the results. This activity lasted for a year, from March 2015 to February 2016.

3.1 Structure of the questionnaire and contacts with the enterprises

In defining the questionnaire we decided:

- to limit the questionnaire to 10 points, in order not to bore the interviewees and to focalize their attention to specific matters and issues;
- to avoid as much as possible open questions, but to drive the answers using closed-ended questions; but, next to some of the closed-ended questions, we decided also to make room for free comments, that allowed the interviewees to add further information;
- to allow the interviewees to complete the questionnaire also in an anonymous way, to guarantee privacy of the information for those who preferred not to inform about their identity;
- to propose the questionnaire to Italian software houses to better evaluate its acceptance and the results, eventually proposing it later to software houses of other European countries;
- to clarify as much as possible, also with some examples, what we intend for e-business standards for interoperability, in order to avoid misunderstanding on the terminologies and on the target of our investigation.

The structure of the questionnaire is the following:

- questions 1-2-3-4 aim to understand the familiarity of the enterprises in working with standard implementations, how many of them resort to standards in their solution development and which are the most used e-business standards;
- questions 5-6-7-9 aim to understand the main criticalities and issues for the software houses in adopting standard data formats;
- question 8 aims to understand the level of satisfaction of the software houses that have used standards in their solutions;
- question 10 allows to add further free considerations.

We proposed the questionnaire in two manners:

- an hard-paper version distributed to the enterprises during some specific events we organized;
- preparing an online copy using the Google drive platform, that allows the necessary flexibility in preparing the questions. The questionnaire is available (in Italian) at:

  https://docs.google.com/forms/d/1cU3XH9AqICO7wdbZ4lA0pLoicabQ0p6QE7-HToro9P8/viewform?edit_requested=true

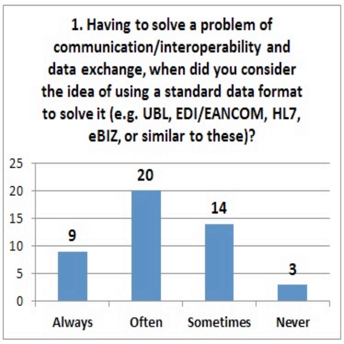
After the set-up of the online version of the questionnaire, we contacted more then 300 enterprises (all of them engaged with different roles and activities in interoperability issues) via email; we collected their contacts in more than 15 years of activities and national/European projects related with interoperability. We also opened some topics in discussion groups related with ICT on the Linked-In platform, asking for the contribution to the investigation. Our aim was to know where are the hampering factors in standard adoption rather than to establish a 'rate of adoption' representative of the whole population.

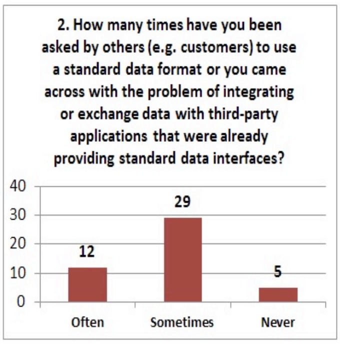
During this phase we had many problems to get contributions from the enterprises: a lot of them are reluctant to complete and to collaborate in such activities, and often have difficulties in understanding the topic of the problem or the core of our investigation. Totally we had 46 valid answers, 25 with the online version and 21 in hard paper format.

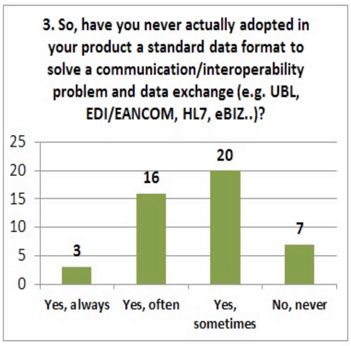
4 Results, analysis and considerations

In this section we will analyse each question of the questionnaire, in order to make the first considerations and to draw the first conclusions.

4.1 Questions 1, 2, 3





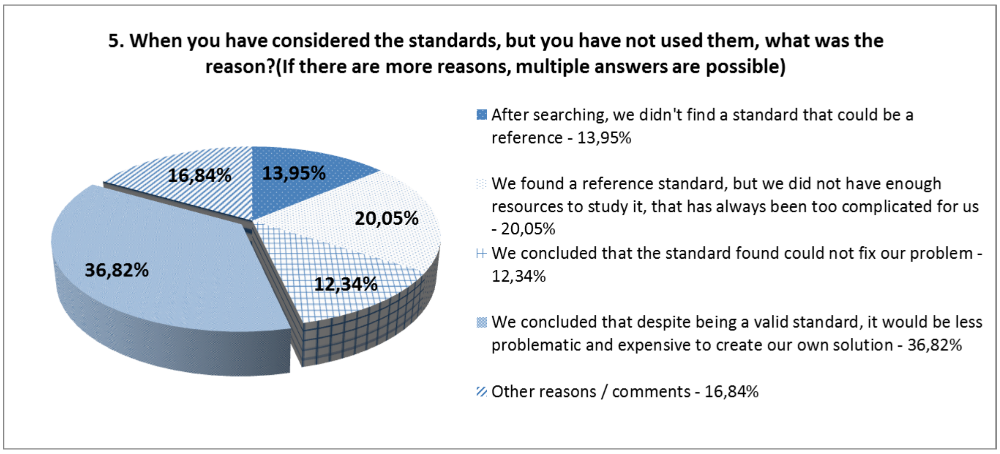


Although a fairly good number of enterprises strongly consider to use standards (question 1), those that finally use them is reduced. Moreover, from the customers and third parties the demand to use standards/standardized interfaces is quite limited and in some case it is absent.

4.2 Question 4

The question is: "If you adopted in your product/solution a standard data format for data exchange, could you cite the standards adopted?", with an open field for the answer. In this case a slight confusion is emerged about what the expression "standard" means: some enterprises pointed out proprietary standards or standards from specific consortia, others declared to use "internal proprietary standards", others considered "XML" as the adopted standard, without specifying more in details its application or the domain specific standard (if any), but remaining in a very generic view. EDI resulted to be the most adopted standard, together with some its sectorial customisations. Other standards cited are: HL7, eBiz, UBL, ISO 20022, FpML

4.3 Question 5

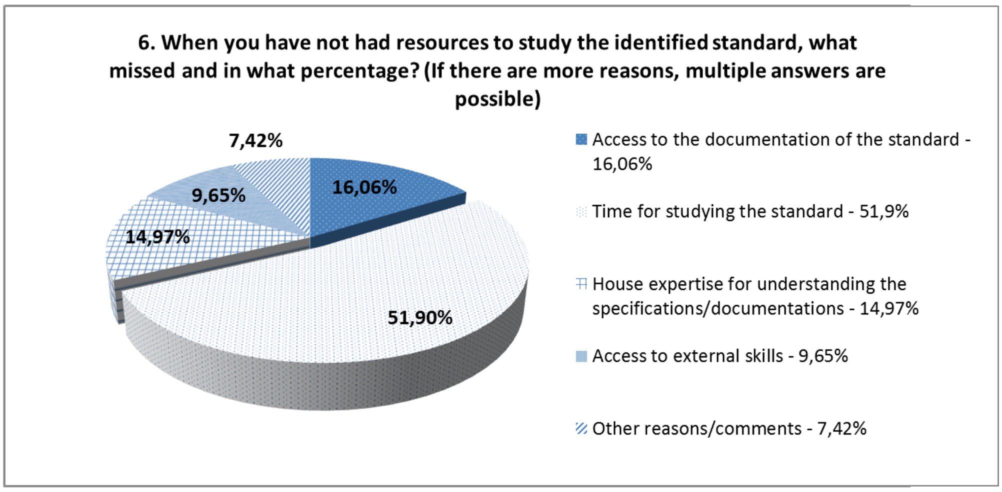


The main outcomes from this question are:

- first of all, only in few cases (13,95%) the enterprises did not find in their activities a suited standard for the implementation of a solution in their target applicative sector; moreover, only in 12,34% of cases the selected standard seemed to be not adequate to the problem. This means that in general standard solutions do exist and are accessible;
- on the other hand, in about 1/3 (36,82%) of the cases enterprises prefer to implement a proprietary solution also if other possibilities, based on standard, already exist and are available;
- 16,84% specify "other motivations" for the missed adoption. Reading the free comments on this option, it seems that basically it is the customer that plays a central role and takes the decision to avoid the adoption of standards, for different reasons (lack of trust in standards adoption, lack of motivations, complexity, lack of knowledge/ awareness, limited scope in use that didn't seem to justify its adoption).

All these considerations seem coherent with the results (see previously) coming from question 1 and question 3, that highlight the gap between the idea of standard usage and its practical implementation, and with question 2, that highlights the lack of interest from the customers in standard-based solutions.

4.4 Question 6



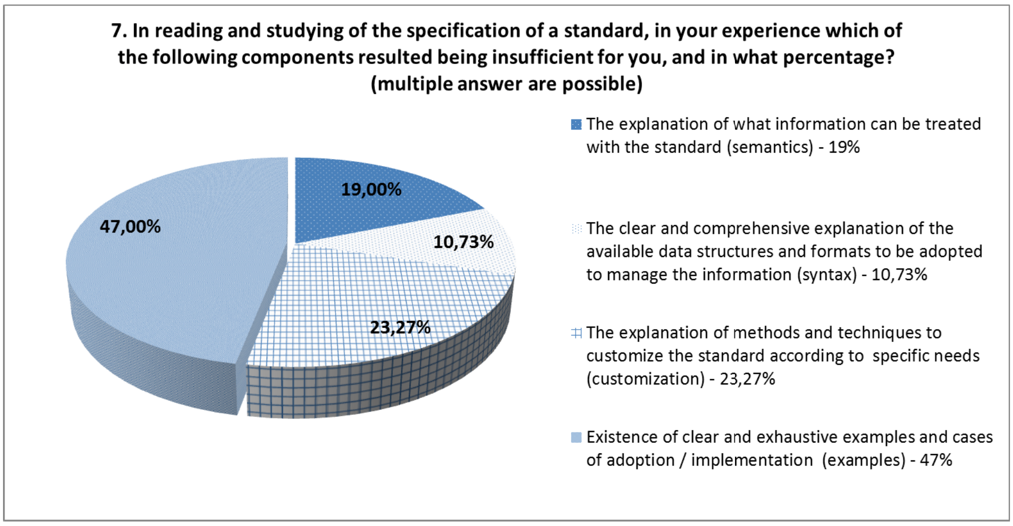
The predominant aspect that emerges from this question is that 51,9% declares that they do not have enough time to study the standard specification and documentation. This could lead to consider three different possible explanations:

- the documentation/specification is too complex and requires too much time for its comprehension;
- the enterprises, the software houses and the developers sometimes are too lazy to examine and deepen the problem and the standard;
- lacking of economic resources that could allow the study. In other words, as expressed in a free comment, what lacks are money to pay an investment on time for studying. This is due also to the perspective of the customer, that "pays for what he/she sees": the customer often is not interested in "how" the solution works, but only that solution "works", preferably in a short time.

Other considerations that we can derive from these results are:

- there is a gap between the developers and the standardization bodies: the released specifications too often result to be difficult to understand (especially for SMEs and small software houses);
- since there is no interest in investing in time for standard study and analysis, this means that the customer does not see a standard-based solution as an advantage.

4.5 Question 7



Also in this case we can notice a predominant aspect: 47% complains the lack of examples, use cases, and evidences about the application of the standard. Other considerations that we can derive from these results are:

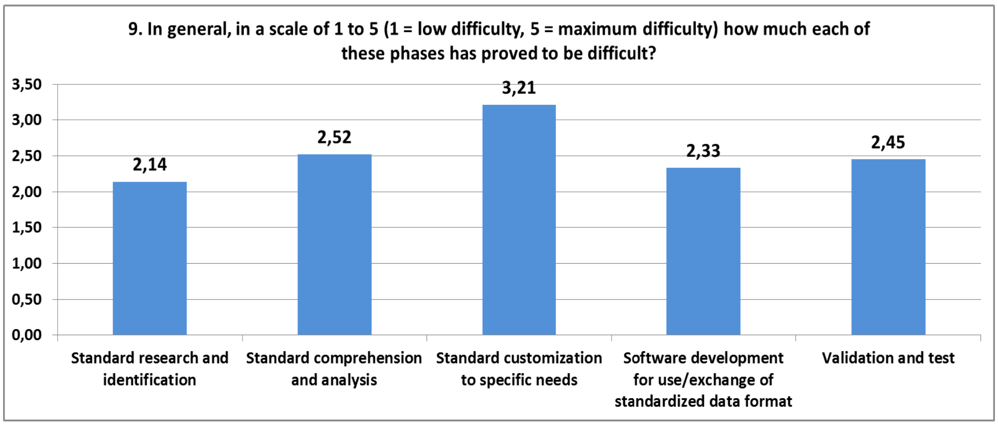
- the other main problem (23,27%) is related with the lack of explanations about customization mechanisms to adapt the standard to specific needs;
- specification about standard semantics and syntax are less problematic and more satisfactory (19% e 10,73%). This may suggest again that the considered standard specifications are "unbalanced" toward a clean and precise presentation, but too abstract, which does not guide towards its practical application. In any case, while syntax specification seems to be quite good, more problems exists on the comprehension of the meaning and of the matter of the standard.
- the previously mentioned result about the lack of time for studying (question 6) might be related to this result about the lack of examples and use cases: the lack of examples makes the study and the comprehension of the specifications more complex and makes more difficult standard application in the implementation of interoperability solutions. This leads the developers to consider unfruitful the time for the study of the specifications.

4.6 Question 8

The question is "When you have adopted a standard, how much were you pleased with this choice, from 1 to 5 (1 =very unsatisfied, 2 = unsatisfied, 3 = sufficiently satisfied, 4 = more than satisfied, 5 = highest satisfaction)?".

For this question we obtained an average value of 3,62. Among the interviewees, very few are disgruntled: nobody rated '1' ("very unsatisfied") for this question and only three ones rated '2' ("unsatisfied"). Likewise few ones rated highest satisfaction. Generally we can say that standard adoption results to be more than a good solution for the developers.

4.7 Question 9



From the previous graph what emerges is that the most difficult phase in standard implementation is the customization for specific needs (3,21). At the second stage there is “Standard comprehension and analysis” (2,52), but it is worth to be noted also that the testing phase is very near (2,45) to the second phase in order of difficulty in this list, highlighting the problem for the developers to practically validate the implemented solution. We can guess several reasons for this difficulty:

- lack of experience and lack of a proper, clear and rigorous methodology in managing and doing the tests, or to the lack of a software system that could support and drive the testing phase in an efficient manner. This deficiency could lead for example: to do and to repeat many times the same class of tests; to do tests that are not useful to highlight the real problems; to not adequately collect (and then to not analyze) data about the results of the tests; to not cover all the possible cases of the problem, missing than the relevant aspects of the practical adoption;
- wrong use by customers of the software under test, that leads to many puzzling errors and problems that require complex, time-wasting analysis and interventions. This could also denote superficiality at design and implementation phase, meaning that the software requires strong revisions and corrections;
- ambiguity in the standard releases and specifications, that leads to software implementations done with care and attention, but that bring with them problems that result from a not accurate and adequate writing of the reference specifications and from difficulties in their interpretation. Ambiguity then is a problem of the standard specification that brings to many different conformant but not-interoperable implementations.

It is also interesting to note that the interviewees consider more difficult and complex the standard study and comprehension than the software implementation and management. This highlights the complexity with which it is perceived to face a standards-based solution.

Finally, a relevant consideration is related with a specific free comment added to the questionnaire: the comments complains the lack of training that is done in universities and post-graduate courses of figures skilled to study, tackle and operate in the world of standards and standardization bodies. Although these figures are useful and required in the industry, this topic (standard and interoperability) is generally undervalued and underappreciated in the courses.

5 Conclusions

The aim of this paper is to try to better understand some difficulties (that we observed in several experiences, and also in European projects) of the software houses in the adoption of e-business standards for the implementation of data exchange/interoperability solutions. In this field problems are on both sides, the "producers" of the standard (the standardisation bodies or committees) and the "consumers" of the standard (the developers), but in this paper we give space to the consumers perspective, in order to find those weaknesses of the standard specifications that "complicate" the work of the implementers: on this purpose we prepared a questionnaire of 10 points that we proposed to a set of software houses. Then we analysed the results of the questionnaire, reporting several considerations. Here we want to highlight and summarize some of them:

- specifications are in some cases too abstract/complex and are not accompanied by examples. Whereas syntax and semantics of the specification are clear and detailed, what lacks are examples and use cases that could help in the comprehension on the practical application; moreover, this lack amplifies the perception of the time needed to study the specifications.
- how to test the implemented solution? Testing is not just a trivial, simple and almost useless verification of the "real" work done during the implementation. Testing is a crucial and complex phase in which all work done before is stressed with real and practical, often unexpected cases. Supporting this phase means providing or suggesting tools to perform tests, both in terms of software and data/information/cases to test with the implemented solution;
- in the great majority of cases, customization is a necessity for the enterprises, and it is unavoidable. Sometime the developers have no idea how to personalize the specification, which mechanisms are available for this and how to proceed without errors;
- lack of awareness of the advantages in using standards. This could be a fault of the enterprises and their customers (that do not sense the advantages of a standard-based solution), but also standardization bodies could emphasize the opportunities, the differences among a proprietary and a standard based solution, the level of adoption of the specifications, the economic and practical advantages with a standard-based implementation.

We think that being aware of these limitations and knowing the point of view of the implementers can in some cases help the improvement of the quality and usefulness of the standard specifications, supporting the work of the developers and increasing the adoption of standards.

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Product Innovation and R&D Management: A Product Life-Cycle Analysis on When to Introduce an Open Interface Standard

Paul-Vincent von Gruben

Technische Universität Berlin,
p.vongruben@campus.tu-berlin.de

Abstract: *Firms that develop product innovations have the choice between pursuing compatibility with other market participants and following a proprietary product strategy. In this paper we find that early in a product's life-cycle until the end of the growth phase but before maturity, agility and self-determined decision making with a private interface is most advantageous whereas further down, at a later stage of the product life-cycle, standardizing the mating face of a product i.e. developing an open interface standard is more beneficial. The developed model is based on the dominance process and reviews the success factors for a technology to become the market's dominant design. The analysed environmental and firm-level factors vary for different product life-cycle stages hence support or oppose an open interface strategy. A supportive empirical analysis explores our predictions by examining a study comprising of four cases with data from a manufacturer of Ethernet connectors. The results reinforce our suppositions. Early stage products have higher revenue growth rates when their interface is retained proprietary, whereas later in the product life-cycle the product with a standardized undisclosed interface maintains a higher growth rate. Academics that have a background in open innovation as well as innovation policy will be interested in our life-cycle analysis which explores the effects of introducing an open standard. Our adapted inductive model furthermore yields implications for the timing and strategic implication of an open interface by R&D management.*

Keywords: *dominant design; interface standard; open standard; product life-cycle analysis; proprietary standard; technological dominance*

1 Introduction

In the product life-cycle analysis of this paper we find that product interfaces should be kept proprietary in early life-cycle stages and further it reveals advantages of an open product interface when introduced before the end of the growth stage of a product's life-cycle. The propositions are based on an adapted model applying the technological dominance framework of Fernando F. Suarez (2004). Suarez segments the dominance process to identify which factors affect its outcome along the technology battle. Comparing the dominance process with a product's life-cycle and applying the relevant standardization economic literature, we develop our arguments regarding the timing of standardizing a product's interface.

In the domain of dominant designs and standard wars, scholars have already developed a number of frameworks which present a series of factors affecting the outcome of the battle between different interface formats and technologies (Lee et al., 1995; Schilling, 1999; Suarez, 2004; Murmann & Franken, 2006; van de Kaa et al., 2011). However, only Suarez (2004) describes the actual dominance process.

Since the early 1980s, a rich body of literature has focused on the effects of standards e.g. Lecraw (1984), David & Greenstein (1990), Tassy (2000), Blind (2004) and Swann (2010), however according to David & Greenstein (1990) there is a lack of a holistic life-cycle analysis approach. They note that standard analysing models which consider dynamic market growth or product life-cycle issues have not been carried out. To date, the literature focuses on the comparison of either standardized or proprietary products (e.g. dominant designs). Hence, by developing an adapted model on the basis of the dominance framework we try to narrow this research gap.

In the developed model, we show that early in the life-cycle a proprietary interface enables the supporter of the respective technology to act more freely as opposed to the necessity to coordinate with other market participants. Negative consequences are reduced time-to-market periods and potential lock-ins with an inferior technology (Farrell & Saloner, 1985; 1986). Additionally, when starting with a proprietary technology firms retain the ability to focus on their own strategic manoeuvring and gives an advantage in the design and production of related components of a developing system (David & Greenstein, 1990). However, as the evolution of an innovative product proceeds, the identified success factors favour a more open approach from the growth phase onwards. In fact, opening up the interface and developing a standard at this point increases the opportunity for further market growth (Farrell & Gallini, 1988; Antonelli, 1994; Swann, 2010). Growth from standardizing occurs due to a combination of factors comprising of the exploitation of economies of scale, the effective division of labour, vertical specialisation, network effects, reduced barriers to entry and decreased uncertainties associated with innovative technologies. However, it is not sufficient to solely trigger market growth, but it is furthermore important to retain or gain high market share. This can be achieved by starting with a proprietary system early in the product life-cycle, to build a critical mass and obtain a large installed base (Farrell & Saloner, 1986; Krechmer 1996; Swann & Watts, 2002). Furthermore, switching costs arise once a customer commits to the focal system (Teece, 1986). Complementary assets are being introduced and further enhance emerging network effects (Katz & Shapiro, 1985; Farrell & Saloner, 1985). Additionally, they help to gain market share or retain market share once the interface has been converted into an open standard. Similarly, Baldwin and Clark (2000) argue that only after sufficient knowledge has been accumulated about an internal configuration of a technical system, design rules and interfaces should specify subsystems.

In a time-series analysis, comprising of four cases which involve products with and without a standardized interface we then confirm our propositions. The descriptive analysis includes quarterly revenue data of products from a manufacturer of Ethernet connectors over a time period of six years. The results show that in the short run, the product with a proprietary interface is slightly more successful in terms of the revenue growth rate. In the long-run, however, the product which includes a standardized interface retains a larger and steadier growth rate. These short-term and long-term findings confirm our initial theoretical propositions. From our results we derive that the introduction of an interface standard does not necessarily need to take place the beginning of the life-cycle of a product innovation, as it is often the case, but proves to be more beneficial at a late life-cycle stage before maturity. Furthermore, we conclude that a more mature product maintains higher growth when its interface architecture has been undisclosed by introducing a formal standard.

Our adapted model has implications for a better understanding of dynamic market growth at different life-cycle stages and for the trade-off decisions between an open compared to a closed system implementation. Although we are able to compare products with proprietary and standardized interfaces, further research needs to be carried out with a greater set of examples. In addition, we suppose to widen the scope of future research on time-series including the opening up of the respective interface. The ICT sector would be a suitable next research target as there are more examples of open interfaces.

In the following section we provide a selective overview of the literature on the effects of standards chosen by their relevance considering the dominance factors by Suarez (2004). We then develop an alternative theoretical model derived from the dominance process framework. Our methodology and the results of our explorative analysis follow thereafter. At last we discuss and conclude what we have found in our product life-cycle analysis.

2 Theoretical Considerations

The development of a theoretical framework for our research represents a combination of insights from two interlinked research fields, standardization economics and standard wars. On the one hand, to overcome our objective and find the optimal timing to introduce an open interface standard, we build on the related domain of standard battles and dominant designs. From research on the dominance process, we adopt the success factors which influence the outcome of standard battles. These factors draw upon experiences and know-how of examples of previous standard wars and their outcomes.

On the other hand, we analyse the well-established and greatly researched scientific field concerning interface standards. We review the relevant effects of these compatibility standards to determine whether a private proprietary or an open public system is most beneficial as a product strategy.

2.1 The Dominant Design And Formal Standards

The analysis of how a technology or interface can achieve dominance in the market is of great interest for academics and especially for practitioners as the winner of the dominance battle collects substantial rents ex-post dominance (Utterback, 1994; Srinivasan et al., 2006). For that reason, research on the factors which influence the success of achieving technological dominance received a lot of attention by scholars from different disciplines. The extensive research consists primarily of empirical analysis of past examples of standard wars and their outcomes. The literature on technological dominance established the terminology *dominant design* or *dominant standard* for achieving high market share (Anderson & Tushman, 1990). The established concepts of dominant standards are market-driven processes which result out of dominance battles between competing proprietary technologies, interfaces or platforms. Usually, these dominating standards have established with the help of a sponsoring firm or firms which have introduced the technology, design or interface. Over the years, a number of literature reviews captured the detected success factors from empirical as well as theoretical studies (Lee et al., 1995; Schilling, 1998; Suarez, 2004; van de Kaa et al., 2011). The most recent paper on the dominance factors was carried out by van de Kaa et al. (2011) and includes 127 papers comprising 29 factors which were found to have an influence on whether a product becomes the dominant format in the market. This holistic overview will be taken as a theoretical foundation of our paper. However, since we want to compare the factors according to their influence at the corresponding life-cycle stages, we will build upon the integrated framework of Suarez (2004) who categorised the factors by their time of influence in the dominance process.

However, the research on dominant designs is missing to point out the alternative that dominance can be achieved by developing a formal industry-wide standard. The existing variety of proprietary solutions would then be in competition with an open formal standard. This can happen with or without competitors knowing, depending on whether they are active in the respective standard developing organizations (SDOs) or not. These commonly agreed upon standards which are developed in standards developing organisations (SDOs) are called formal standards (e.g. ISO, IEC, DIN, ANSI or IEEE). Formal standards are perceived to be an open type standard because they are developed in a consensus of all interested parties including firms, governments and other organisations. Participation is free of charge, self-expenses of participants are the only costs involved during the standardization process. Most importantly, the documentation of the standard is publically available and can be obtained for a small fee payed to the independent institute handling the process and administration of the standard. The literature on dominant designs and formal standards characterises a number of different standard types e.g. product standards, process standards or quality standards. However, in this paper we will focus solely on sponsored interface standards. A sponsored standard means that a focal firm holds particular interest in the establishment of that standard (David & Greenstein, 1990).

During the process of new product development (NPD) the choice to develop a standard for a product for example to reduce the risks and uncertainties of R&D investments is well established and has been the issue of multiple studies (see e.g. the review of David & Greenstein, 1990). There are a series of other reasons to join the standard committees especially in new innovative areas to stay up to date with the development in the market for example. In his study, Blind (2006) found that standards are especially beneficial for new technologies to diffuse within the industry. Other factors disadvantage firms or technologies when they join standard organisations, e.g. the late market entry due to intensive coordination.

2.2 Interface Standards And Their Effects

The elementary function of interface standards is compatibility of two components which includes physical or functional interoperability. This can be achieved by codifying the requirements to facilitate interaction (Utterback, 1994; David & Steinmueller, 1994; Kahin & Abbate, 1995; Krechmer, 1996; De Vries, 1999). Apart from the interface's primary function, the mating of components, dominant designs and formal standards furthermore have an economic impact on the products performance. Standards can be a strategic tool for firms to reduce costs or increase sales. They furthermore have the ability to influence the environmental and competitive circumstances. The firm-level and environmental economic effects of standards have been intensively researched since the 1980s and 1990s (Farrell & Saloner, 1985; 1986; Katz & Shapiro, 1985; Salop & Scheffman, 1987; Matutes & Regibeau, 1988; David & Greenstein, 1990; Blind, 2004; Swann, 2010).

2.2.1 Interface Standards And Market Segmentation

Shapiro & Varian (1999) have pointed out that "an (open) standard shifts the focus of competition from systems to components". This is a key aspect considering the decision whether the standard is designed as an open or a proprietary system. In this function, open interface standards change market structures breaking up complex "turnkey" systems of mostly large companies with previously proprietary interfaces linking the system's components (Tassey, 2000) into "mix and match" market environments with more potential for growth (Matutes, & Regibeau, 1988; Farrell, Monroe, & Saloner, 1998). Furthermore, standardization opens new markets especially for modular components (Murmann & Frenken, 2006).

The implementation of a standard does not only shift competition from systems to components by splitting up markets causing product and market segmentation but this effect furthermore increases efficiencies in the market through division of labor (Antonelli, 1994; Swann, 2010). Professionalization on a component level as well as higher rate of economies of scale provides opportunities for reducing production costs. The described effect of division of labor causes a decrease in expenses which will ultimately result in lower market prices, enabling the exploration of new and more price-sensitive markets for the respective product.

Further market enlarging factors of a standard have been studied under the domain of two-sided markets (Eisenmann, Parker & Van Alstyne, 2008). The nature of an interface standard as a platform creates further opportunities. It enables the access of one component and its network to connect to another component and its associated network. Possibilities for new innovations arise “on either side of the interface” (Tassey, 2000). The two-sided market creates further *indirect* network externalities as it increases a two-way contingency between the demand and supply of the matching interfaces of a system’s components (Gupta, Jain & Sawhney, 1999). In the case of an interface standard which remains backwards compatible with older versions of a new developed version of a product, increases the velocity in the innovation cycle. Furthermore, it allows for substitution of existing components by more advanced ones as they become available (Tassey, 2000).

2.2.2 *Interface Standards And Economies of Scale*

A series of effects of formal compatibility standards lead to market growth, these include the effect to reduce the number of alternatives and thus increasing the efficiency in the market enabling exploration of economies of scale (Lancaster, 1975; Farrell & Saloner, 1986). Furthermore, from a market perspective, fragmentation with a large variety of solutions can only be overcome by compatibility of the different systems achieved through standardization (Shapiro & Varian, 1999). The additional variety of compatible applications and interconnected products further enlarges the market overall (Matutes & Regibeau, 1988). Although standards reduce the variety of alternatives, it increases the opportunities for new compatible products at the same time due to a shift of competition between systems to a competition between components (Farrell, Monroe & Saloner, 1998; Shapiro & Varian, 1999). The greater variety potentially increases the overall market size. The possibility to mix and match components (Matutes & Regibeau, 1988) furthermore increases the usage for the customers of the newly broken up system. In markets where network externalities are present, an interface standard will increase demand for the product due to excess complementary products and hence the value of the product system (Church & Gandal, 1996; Farrell, Monroe & Saloner, 1998; Gallagher, 2007).

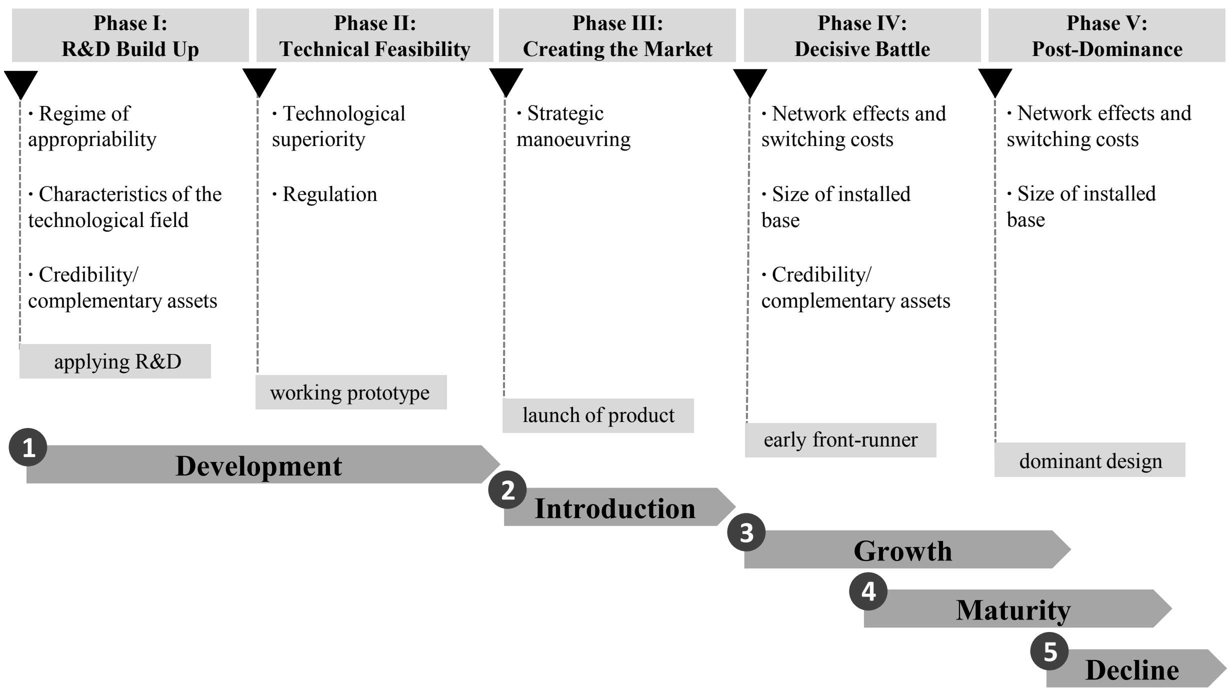
2.2.3 *Interface Standards, Switching Costs and Second Sourcing*

Another relevant factor describes the fear of customers to commit to a product or system which is exclusively available from a single supplier with a proprietary interface or technology. These customers prefer systems with an open architecture produced and supplied by multiple manufactures (Farrell & Gallini, 1988). The reason behind the fear is that a steady supply might be interrupted. A pool of multiple suppliers reduces external risks such as deficiencies or shortfalls which might intercept the production process. The resulting deficits will lead to additional costs and delays. The risk of higher future prices is a second reason for so called *second sourcing* strategies. Demands for a product are expected to be smaller when there is a risk of expected higher prices in a second-period purchase (Farrell & Gallini, 1988), in the case of proprietary interface or technologies. Switching costs further prohibit the commitment of potential customers (Teece, 1986). Further uncertainties existing in the market due to variating technological architectures prevent customers or producers of complementary products to commit ex ante dominance. Especially technology followers tend to wait for a single design to win the standards war (Hatfield et al., 2001).

2.3 Technological Dominance And Product Life-Cycle

2.3.1 The Dominance Process

The framework of Suarez (2004) on the dominance process is based on a literature review looking at factors which are important at the respective phases of the technological dominance process. The considerations include theoretical and empirical evidence from the dominant design and standards literature. He identified the following factors to be most important during the first phase in the subsection of 'R&D build-up': *credibility of a firm and complementary assets*, *regime of appropriability* as well as the *characteristics of the technological field*. In the second phase named 'technological feasibility' the following factors were identified as important: *technological superiority*, as well as *regulation and institutional intervention*. In the third phase named 'creating the market': a *firm's strategic manoeuvring* was identified as most important. In the fourth phase which describes the 'decisive battle': *network effects and switching costs*, the *size of the installed base* as well as the *creditability and complementary assets* are most important. In the fifth and last phase named 'post-dominance' he identified: *network effects and switching costs* as well as the *size of the installed base* as most important.

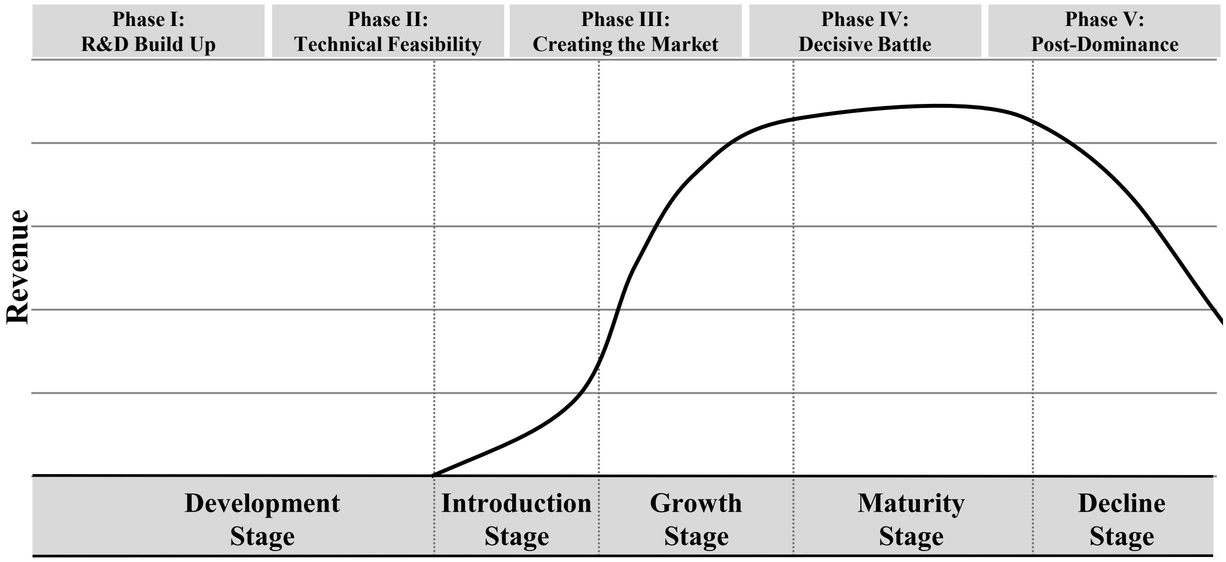


Source: adapted concept from Suarez (2004)

Figure 1: The technological dominance process and the product life-cycle

2.3.2 The Product Life-Cycle

In addition, for a more general understanding of the product developments and performance, we furthermore look at the common life-cycle of a product. The combination of the dominance process with the product life-cycle framework provides a theoretical model which is the staring point for our propositions about the timing of the standard setting process. The basic product life-cycle typically includes the (1) *development* process and the product (2) *introduction* which marks the commercial birth of a product. During the (3) *market growth* stage and up to market (4) *maturity* of a product, the maximum of monthly revenue is being reached. In the final stage of a product's life-cycle, the product shows a negative growth rate and sales (5) *declines* until it eventually exits the commercial market or is being replaced. The revenue curve exemplified in figure 2 shows the development of the revenue of a normal product. Revenue starts to increase after product introduction at a slow pace. The steepening of the revenue curve marks the entering of the growth phase which lasts until market demand for the product decreases indicating saturation. This is called the maturity phase. Eventually growth stagnates completely and starts to turn negative. The product has reached the decline phase and will eventually drop out of the market (see e.g. Clifford, 1965; Cox, 1967; Polli, & Cook, 1969).



Source: Adapted from Suarez (2004) and Polli, & Cook (1969)

Figure 2: Exemplified product life-cycle combined with the dominance process

3 A Theoretical Model: Interface Standards in Product Life-Cycles

The framework for our concept comprises of the factors from the dominance process as mentioned in the previous section. These are a compilation of firm-level and environmental criteria identified by Suarez (2004) who also discusses the influence of *regulation and institutional intervention*. He classifies the factor as being most effective at an early stage of the dominance process together with the technological superiority in Phase II. This seems reasonable considering the case of an intervention by the government to privilege a certain technology through regulation or restricting standardization institutes (e.g. the US television broadcast standard by RCA, or the European GSM vs. CDMA). However, the in the majority of cases standards are sponsored by firms and are of no interest for the general public or government. Nevertheless and interestingly enough the view of Suarez (2004) is in line with the existing research by scholars from the standardization field. The vast majority assumes that the development of standard takes place during the R&D phase of the new development. Bearing that in mind, two scenarios have been analysed. In the first scenario, a product competes in the market; no compatible standard is being developed. The product competes in the market as described by Suarez (2004).

Scenario 1 *Market entry with a proprietary interface architecture (no formal standard)*

Market entry ● Proprietary system (interface without formal standard) ► Market drop-out

In the second scenario, a new product innovation enters the market only after the standard is published which describes e.g. the interface between two components. The standard can be updated but is rarely substituted or replaced by a totally different or competing standard.

Scenario 2 *Market entry with an open interface architecture (including a formal standard)*

Market entry	●	Open system (interface with formal standard)	►	Market drop-out

The concepts above represent the two research streams of dominant design (first example: proprietary from entry onwards) and the open standards perspective (second example: including a formal standard from beginning onwards). However, we will look at the product life-cycle to find out if the introduction of a standard might be more adventurous at a later stage rather than right from the beginning.

This option describes a process where a company's product enters the market with a proprietary interface and fosters an open formal interface standard at a later stage in the product life-cycle. For that purpose we take the framework of the technological dominance process developed by Suarez (2004) to find out which of the five stages in the process favour the proprietarily factors and which stages would benefit form a standard system.

Scenario 3 *Market entry with a proprietary interface and later development of a standard*

Market entry	●	Proprietary system (interface without formal standard)	►	●	Open system (interface with formal standard)	►	Market drop-out

In order to find out the right timing for the development of a standard, we compare the dominance factors with the literature streams of dominant designs and formal standardization.

3.1 Early In The Product Life-Cycle

3.1.1 Development Stage (Phase I)

(i) Credibility/ complementary assets: Next to expert knowledge and technological talents (credibility), speed to market of a technology and the market entry timing plays a major roll. By choosing the option to introduce a new development including a formal interface standard instead of one with a proprietary interface, changes the agility of the interface sponsoring company. Although without the commitment to a common standard which might increase the compatible product portfolio, at this early stage the technology will most likely be only half-baked and will undergo a couple of changes as the learning effects set in (Klepper & Simons, 2000). On the other hand, another factor is the technological risk associated with the new product. Starting the formal standardisation process early reduces this risk or allocates the risk to all participants active in the development process at the SDO. This however introduces another risk connected to the velocity of the technology entering the market, as the standardization process on a national or even international level is time consuming (Farrell & Saloner, 1988). The harmonization of differentiating interests of the involved parties can take up to three years (Kang & Motohashi, 2015). The costs associated with a delay in time-to-market of a product as a result of extensive negotiations can be significant (see Farrell & Saloner 1985; Katz & Shapiro 1985).

(ii) Regime of appropriability: The risk of knowledge spill overs can be reduced by keeping the innovative technology and its interface proprietary in the beginning. Even if the business environment promises a high degree of appropriability, the best way to protect R&D efforts especially at an early stage is to keep the know-how secret or even protect the knowledge by

patents. Within a regime of high appropriability firms are more capable to appropriate a high degree of their innovation rents than in weaker regimes (Levin et. al., 1987). Furthermore, a high level of appropriability lowers the risk of bandwagon and free-rider when a proprietary system is applied (Katz & Shapiro1994).

(iii) Characteristics of the technological field: Research in industrial economics has shown that initial market structure along the value system can affect the success of firms' standardization efforts (David & Greenstein, 1990).

3.1.2 Introduction Stage (Phase II)

(iv) Technological superiority: The ability to continuously improve the technology will support the effect of a firm's technology to achieve superiority compared to its competitors. This can also be achieved through experience with the product in the market and with customers (Klepper & Simons, 2000). A proprietary interface can be favourable at an early stage also because the early establishment of a formal standard can lead to a lock-in with an inferior technology (Dosi, 1982; Farrell & Saloner, 1986).

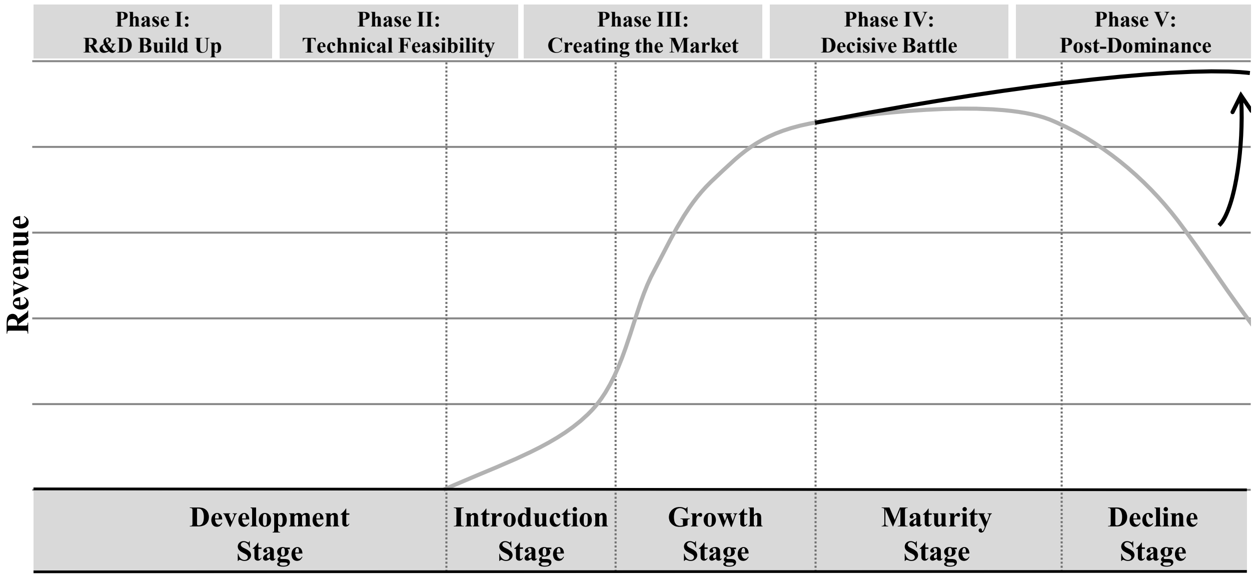
(v) Regulation and institutional intervention: Regulation has an important role in the dominance process as their decisions are legally binding. However, their decisions may not always be in favour of the sponsoring firm. On the other hand they can be a strategic tool to deliberately excluding market players by specifying a standard incompatible to competitors products (Weiss & Sirbu, 1990; Antonelli, 1994) or disadvantage rivals by raising their costs (Salop & Scheffman, 1987). The ability of individual firms to influence governmental decisions is limited. On the other hand, regulation can also restrain innovation. At least at an early explorative stage a variety of options support technological development. As mentioned above, in an early stage institutional intervention such as of a SDO might slow down the dominance or development process of a technology due to long negotiations. The market entry will be much later than without institutional part-taking.

3.1.3 Growth Stage (Phase III)

(vi) Firm's strategic manoeuvring: the ability to make changes to the interface and act independent from competitors using a proprietary interface is eminent. Effects of the first-mover advantage have a highly positive impact on the dominance outcome and were found to be more successful (Lieberman & Montgomery, 1988). Self-controlled product pricing or marketing will help the firm's product to set off and grow market share. These factors are more difficult to control with an open formal standard in place. Price competition is higher and differentiation through variation is limited.

3.2 Late In The Product Life-Cycle

The time in the product life-cycle when revenue growth stagnates indicates the end of the growth phase and passes on to the maturity phase. This suggests a saturation of the market and as a result, competition increases. Self-determent decision making gets displaced by factors which push an existing market to maturity and finally to the last phase called decline phase. Suarez (2004) names this stage the "decisive battle" followed by the "post-dominance" stage. Market growth will not go on forever, however, whereas in previous stages revenue growth was feasible due to overall market growth, at the maturity stage, revenue growth will only be possible by winning excess market share off competitors. Alternatively, further market growth has to be generated or results due to external changes. As outlined in the literature review, the introduction of a formal interface standard and thereby opening up the interface can a method to provoke market growth. Accompanied factors such as the division of labour and market segmentation have catalytic effects on the growth. The opening up and documentation of the interface, however, bears the risk that competitors gain all of the benefits of the standardization and new entrants emerging. This is a common barrier for companies to enter the standardization process as well as the risk of knowledge spill-overs. In the following, we continue our arguments to start with a proprietary interface, however we identified further factors from the dominance process describing the actual battle for dominance which help to retain or even gain market share and a the same time benefit from the standardization. The line of argument enables further revenue growth beyond the previous saturating market. This is visualized in figure 3.



Source: Adapted from Suarez (2004) and Polli, & Cook (1969)

Figure 3: The effect of standards: division of labour and increase in efficiency on the product life cycle

3.2.1 Maturity Stage (Phase IV) and Decline Stage (Phase VII)

(vii) Size of installed base: At this point in the product's life-cycle according to our argumentation a firm will be better off changing from a proprietary to a more open strategy in order to gain further market growth; this can be achieved by developing a formal standard for the interface of the product. Considering the factor of a large installed base, the initial proprietary interface strategy might prove advantageous as the build-up of a large base can be achieved more easily using the options or a firm's strategic maneuvering. However, once this installed base in build and market share is high then the opening up can change market structure. The advantage of a large installed base is achieved by keeping the interface restricted in the early stages of the product life-cycle so only the focal firm is able to provide the product. The result is a domination of the market for that particular technology trajectory. The high market share with the large installed base strengthens the owner of the previously closed interface once the standard has been developed (Farrell & Saloner, 1986).

(viii) Network effects and switching costs: When a firm sponsors an interface standard it should have an early version of that (proprietary standard) already in the market. Therefore, before opening up the interface to the public during the standardization process the company can increase the switching costs for customers to change to competing technologies. The existing base can furthermore attract more customers to join the network. These network effects raise the demand with each new participant (Katz & Shapiro, 1985; Farrell & Saloner,

1985). Furthermore, demand increases as a result of standardizing a product's interface due to its lower transaction costs and enhanced diffusion rates (Antonelli, 1994).

(ix) Credibility/ complementary assets: Once a focal firm has established the proprietary interface in the market, there will be complementary product portfolio building up around the technology. This effect further helps once a formal open standard is to be developed. The introduced formal standard will reduce the fragmented market of the different technological trajectories through the open compatibility standard (Shapiro & Varian, 1999). The introduction of a standard additionally provides creditability and encourages complementors to make supporting investments to extend the base of complementary assets (Farrell & Katz, 2000). Further, Shapiro and Varian (1999) use the example of XEROX's Ethernet standard to outline how the use of a formal standards body can establish credibility and that the open networking standard IEEE 802.3 created self-fulfilling expectations for the Ethernet to emerge as the accepted industry standard.

Table 1: Literature overview: a theoretical model

Proprietary Closed System			**Standardized Open System**	
(i) credibility/ complementary assets	(iv) technological superiority	(vi) strategic manoeuvering	(vii) installed base	(vii) installed base
- creditability through market presence with proprietary product – reputation (Klepper & Simons, 2000; Gallagher & Park, 2002)	- Prevent lock-in with inferior technology (Farrell & Saloner, 1986) - experience with product *(e.g. company standards)* - internal learning (Klepper & Simons, 2000)	- first-mover advantage (Lieberman & Montgomery, 1988). - flexibility (Hanseth et al., 1996)	- large installed base of product technology through prior proprietary product (Farrell & Saloner, 1986)	- large installed base of product technology through prior proprietary product (Farrell & Saloner, 1986)
(ii) regime of appropriability	(v) regulation		(viii) network effects and switching costs	(viii) network effects and switching costs
- high appropriability - appropriate a high degree of their innovation rents (Levin et. al., 1987) - high appropriability helps to avoid bandwagon and free-rider (Katz & Shapiro1994)	- specifying the standard incompatible to existing product of non-participant (Weiss & Sirbu, 1990; Antonelli, 1994)		- existing complementary products in the market – switching costs (Teece, 1986)	- existing complementary products in the market – switching costs (Teece, 1986)
(iii) characteristics of the technological field			(ix) credibility/ complementary assets	
- initial market structure can affect the success of firms' standardization efforts (David & Greenstein, 1990).			- compatibility reduces fragmented markets – network externalities (Shapiro & Varian, 1999) - standard encourages complementors to make supporting investments (Farrell & Katz, 2000)	
Early in the product life-cycle			**Late in product life-cycle**	
Development	**Introduction**	**Growth**	**Maturity**	**Decline**

4 Methodology

The research on open formal standards has not yet considered the dynamic developments of a product and its market as a time series analysis. For that reason a thorough case study analysis provides insights for a comprehensive understanding of the products life-cycle changes (Eisenhardt, 1989). In order to investigate the impact of standardizing the interface of a product and to explore differences between life-cycle stages, we analysed product data of four cases. These four cases comprise a matrix of two-times-two including four products (see figure 4). The two products in the top row of the matrix have a proprietary interface (P1 & P2) and the two products in the bottom row have a standardized interface (S1 & S2). Furthermore, the two products in the left column represent early stage products (P1 & S1) which are relatively new releases and the two products in the right column (P2 & S2) are at a late life-cycle stage with a longer presence in the market.

	Early in life-cycle	**Late in life-cycle**
Proprietary interface	**case P1**	**case P2**
Standard interface	**case S1**	**case S2**

Figure 4: Matrix of the four cases including life-cycle stage and interface type

The underlying data for the analysis of this paper stamps from a large electronic manufacturer from Germany. The analysed products are connector devices which comprises of two matching components, a plug and a socket which are interlinked by their interface. The four products are different in their interface design and life-cycle stage but are all varieties of Ethernet transmitting devices. The criterion to include the chosen products is based on their technological similarity and their life-cycle stage. Compatibility of the two components of a connector can be assured, either by purchasing the two components from the same producer who developed a proprietary interface or by an open market standard describing the interface. The proprietary interface represents a closed system configuration (P1 & P2) whereas the system including a formal interface standard describes an open approach (S1 & S2). For a generic understanding we include two product systems of each type of interface in our time-series analysis. In order to build on findings from the technological dominance process and to test our propositions from our theoretical framework, we analyse products of different life-cycle stages.

For our explorative approach we conduct a descriptive analysis of the product's performance in terms of their revenue growth rate over a time period of six years. The revenue growth rate was chosen to get an indicator of the market and the market development. With the help of this initial assessment we aim to find evidence for our theoretical assumptions. We would expect the product P1 with a proprietary interface to have a higher revenue growth rate than S1. Further, when comparing the products representing more mature products, we expect product S2 with a standardized interface to have a higher revenue growth rate.

5 Findings

For our analysis we look at the revenue growth developments of four products over a time period of six years from 2006 to 2012.

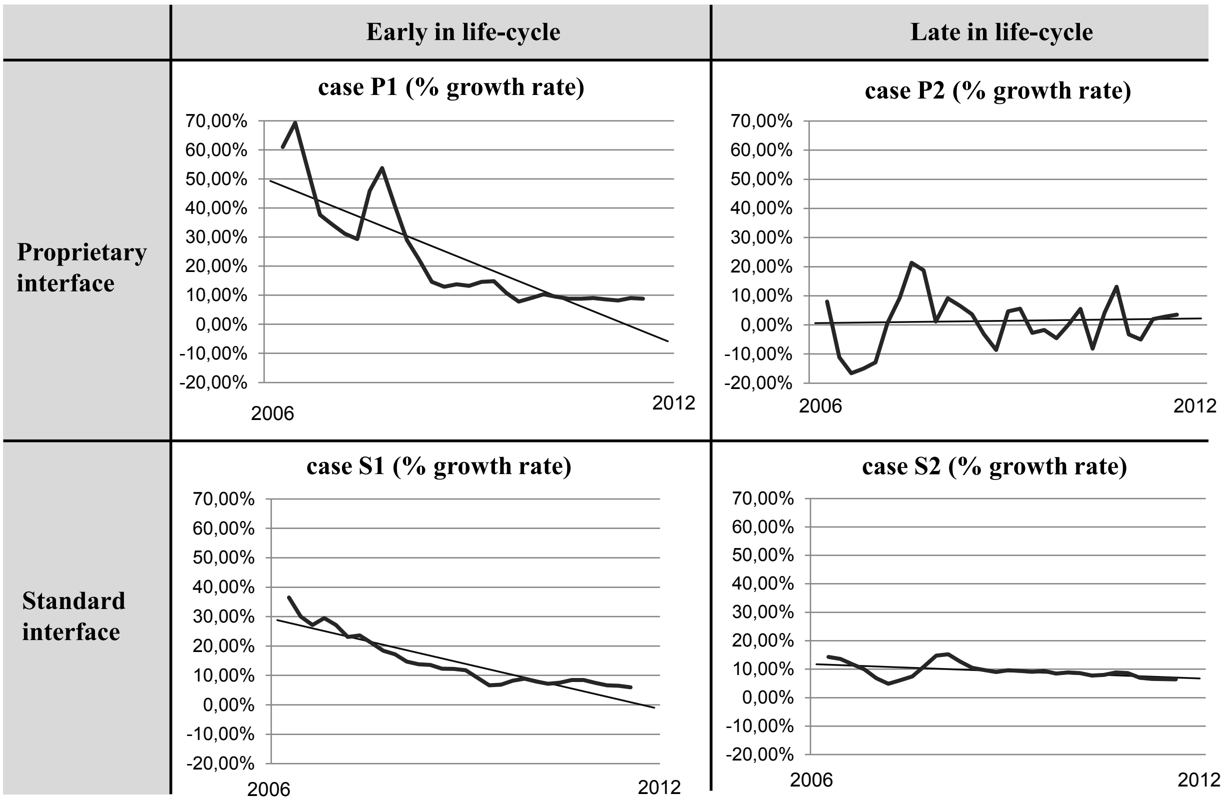


Figure 5: Revenue growth rates of the four cases

5.1 Case P1 (proprietary interface; early life-cycle stage)

The first case which describes a growth stage product including a proprietary interface (P1) has been introduced to the market only shortly before the time-series begins in 2004. We can see in figure 5 that the revenue growth rate two years after the product has been introduced remains at a very high rate between 40-60% revenue growths per year. However, the figure rapidly declines and growth slows to settle at approx 10% revenue growth rate per year in 2009 and following till 2012.

5.2 Case S1 (standardized interface; early life-cycle stage)

The next case which describes a growth phase product including a standardized interface (S1) was introduced to the market the same year as P1 in 2004. Here, slightly lower revenue growth rates than for P1 can be observed. Two years after being introduced to the market the growth slows down from rates between 20-40% per year in 2006 to a similar steady revenue growth rate as P1 at approx. 10% per year from 2009 onwards.

5.3 Case P2 (proprietary interface; late life-cycle stage)

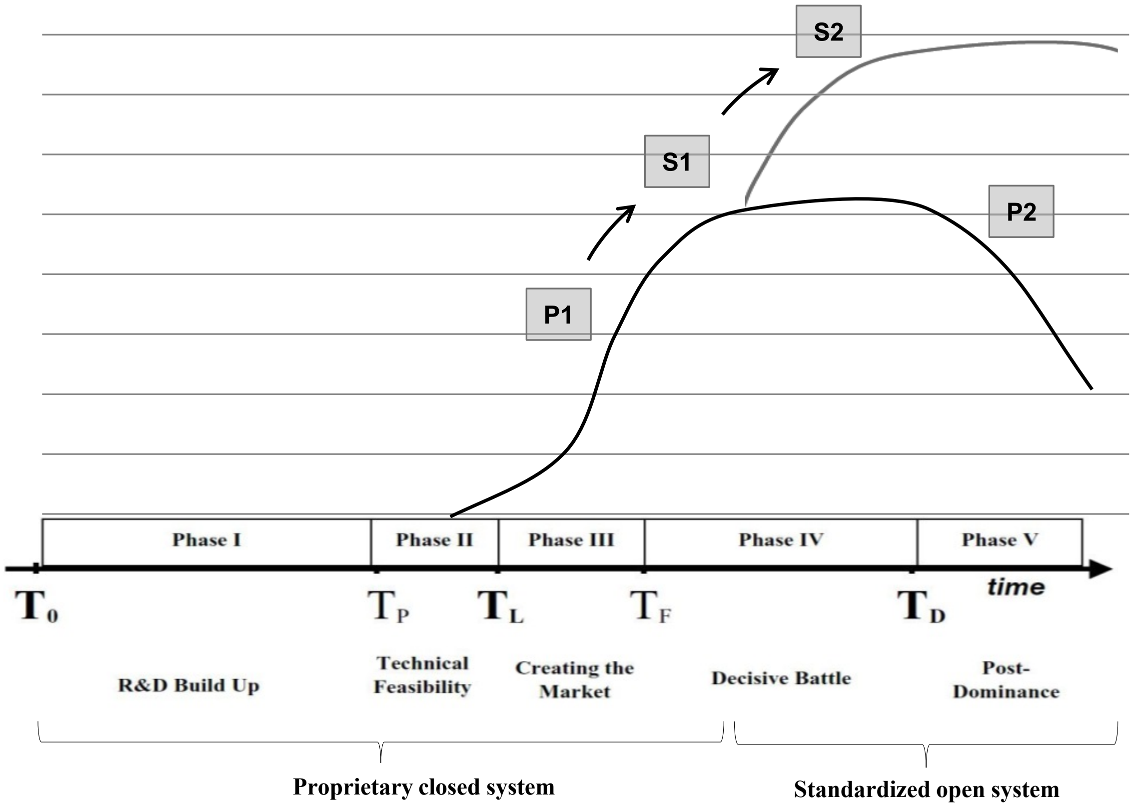
The next case which describes a mature/decline phase product including a proprietary interface (P2) was introduced to the market in 1983 and is therefore already at a very late stage of its product life cycle. As can be seen in figure 5 revenue growth rates are very unsteady and on average close to zero. This does not change over the time of observation.

5.4 Case S2 (standardized interface; late life-cycle stage)

The last case which describes a growth/mature phase product including a standardized interface (S2) has been developed in 1973 and was standardized in 1996. Although the product is older than the proprietary pendant P1, it was able to remain a steady revenue growth rate of approx. 10% over the time period from 2006 to 2012. At the same time it shows far less volatility over the years.

6 Discussion

We use this inductive approach of a detailed interpretation of the raw data to enhance our theoretical model (Thomas, 2006). In figure 6, we exemplify where the products of our cases were to be positioned along the common revenue curve of a product life-cycle. Both, in our theoretical framework model and in the enhanced model (figure 6) the proprietary interface including product stands at the very beginning of the life-cycle. Over time, in theory as well as from our descriptive analysis of the revenue data we find that a standard should be introduced around the growth phase. If the interface is kept proprietary even when maturity begins to set in, the product might end up like case P2 with growth rate close to zero. The case S2 exemplifies the shift of S1 to pursue a higher growth rate as an effect of its opportune interface standardization.



Source: Adapted from Suarez (2004) and Polli, & Cook (1969)

Figure 6: Conventionalization of the results in the context our theoretical model

7 Conclusion

We find that the literature provides backup for our theory of a mixed-approach with a change in strategy from a closed to an open architecture of the interface along the life-cycle of a product. Early in a product's life-cycle of a proprietary approaches seem favourable whereas at the end of the growth phase and before maturity phase, the introduction of a formal standard appears to create the opportunity to achieve further market growth and at the same time keeping market share high due to early dominance with a proprietary system. The empirical results also confirm the short-term effects of proprietary and long-term effect of a standardized interface.

Although we are able to compare products with proprietary and standardized interfaces, limitations are our small set of products. Further research needs to be carried out with a greater set of examples. In addition, we suppose to widen the scope of future research for example to examine the ICT sector, which comprises more examples of open interfaces. Future research should include a greater sample with more industries covered. Furthermore, it would be an interesting case to look at a time-series analysis which explicitly covers the performance of products which change their interface from a proprietary system to an open standardized one.

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Interface Standard Governance and Openness in the Mobile Ecosystem – Implications for Innovation

Hanne Kristine Hallingby

Telenor Research and University of Oslo,
hanne-k.hallingby@telenor.com

Abstract: *The traditional mobile industry expresses worries for the future due to converging technologies and new actors, and intensified tension between open and closed technologies and appropriation and adoption conditions. This paper assesses the status of six standardization fora in the mobile telecommunication ecosystem with regards to the two concepts supply and demand side standard governance, using theoretical lenses from open innovation. It suggests that standardization fora must ensure adoption by complementors through open demand side standard governance and balance open and closed standard governance on the supply side in order to drive innovation and profit. The paper contributes with a typology that can guide firms in how they balance open and closed standard governance in order to reach both strong appropriation and adoption conditions.*

1 Introduction

The mobile telecommunication industry is based on a networked technology where standards and standardization fora are essential (West, 2007); (Edquist, 2003); (Funk & Methe, 2001). It is debated if standardization is an obstacle or enabler to innovation (Blind, 2013); (Choi, Lee, & Sung, 2011). The on-going discussion among mobile network operators reflects this; will standards – along with digitized and converging technologies lead to further innovation and success for the mobile network operators, or imitation and substitution of their services (GSMA, 2014)? This tension between adoption and appropriability – the creation and capturing of value – is a recurring issue both in the information and communication technology industry and other sectors (West, Salter, Vanhaverbeke, & Chesbrough, 2014); (Laursen & Salter, 2014); (Farrell, 2007); (West, 2007); (Teece, 2006) (West, 2003); (Teece, 1986). The firm – or group of firms – faces the dilemma of sharing technology, knowledge and economic return through standards in order to enable variety creation, innovation and growth among its collaborators and complements, and still be able to protect and profit from own innovation through for instance intellectual property rights (IPR). However, standards come from somewhere (Farrell & Simcoe, 2012); (West, 2007) and practices of standardization fora affect the openness of their standards (Takanashi & Lee, 2013). Summing up half a century of innovation studies, Martin (2013) holds that this balance between openness and protection is one remaining task for innovation studies.

I am puzzled by this unresolved tension between open and closed standards and standardization fora, both in theory and practice. My research question is: Are important standardization fora in the mobile telecommunication ecosystem open or closed? I answer this question by comparing and analysing six cases from the telecommunication ecosystem. More specifically, I investigate their openness by exploring those aspects of standardization fora that go beyond the pure technological specifications (Takanashi & Lee, 2013). I use the results to discuss adoption and appropriability conditions for the cases. The research contributes in two ways. First, I refine the evaluation criteria for standardization fora's openness. Second, I provide two concepts of standard governance and an openness typology for standardization fora. These models facilitate openness assessments, and discussions of adoption and appropriability conditions in the telecommunication industry. In section two I introduce the theoretical approach. Section three describes the research design and develops the two concepts. Section four is a short description of the cases. The result of the case comparison is provided in section five, discussion in six and conclusions in seven.

2 Theoretical approach

At the core of the tension between adoption and appropriability in technology development is the discussion of knowledge as private or public goods (Fagerberg, 2003); (Castellacci, 2008); a fully public good is non-rival and non-excludable. It is the possibility to exclude others from the use of technology with IPR that often constitutes a private good. Public goods characteristics of a technology lead to more innovation because it is easier for all types of stakeholders to take advantage of it. However, it is then harder to make direct profit from the technology in question; this is often referred to as a firm's adoption and appropriation capabilities. It is easier to retain profit from a technology with private goods characteristics, but more difficult to spur the necessary innovation among complements in a networked and interdependent market. Thus, based on a firm-centric theory of innovation where profit is essential (West, Salter, Vanhaverbeke, & Chesbrough, 2014), the firm must decide on which parts of profits to surrender and technologies to share as public goods. This tension between the benefits coming from respectively public and private goods characteristics are also at the core of the discussion about standardization as either an obstacle or enabler to innovation (Blind, 2013); (Choi, Lee, & Sung, 2011). It is also a central dimension discussing other aspect of technology openness, such as open source, open innovation, technology revealing and application programming interfaces (API).

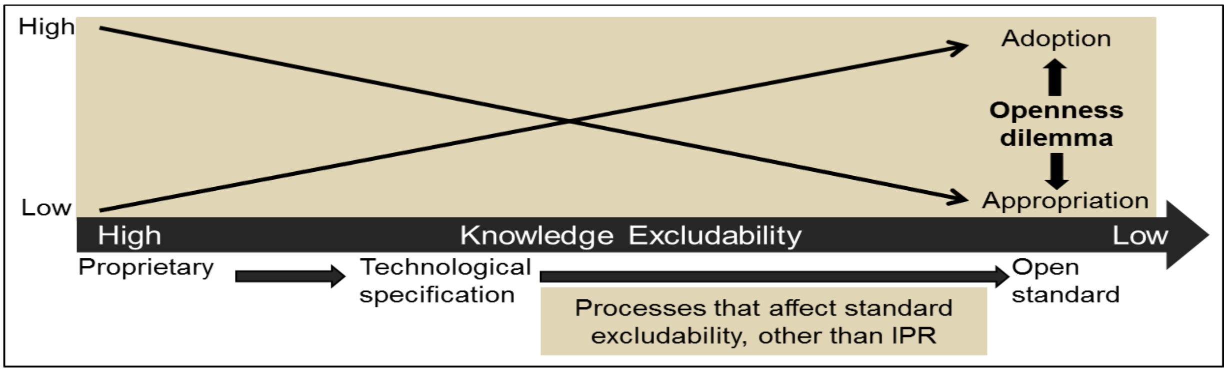

Figure 1 Conceptual framework: Knowledge excludability and open standard implications

The evolutionary innovation field suggests that knowledge seldom traverse directly from being private to fully public, i.e. there are imperfect knowledge spillovers between actors. Rather, knowledge is understood as something that is slowly diffused due to social processes, for instance human inability to share, absorb and take advantage of knowledge (Castellacci, 2008); (Malerba, 2005). This understanding of knowledge lies behind the suggestion that is takes more than technology specification to make standard open, and there are more means than IPR to close it (West, 2007); (Takanashi & Lee, 2013). The EU project NO-REST (2005) provides criteria to be fulfilled in order to make a standard *open*; the criteria are foremost a list of how to make technical specifications available and reduce knowledge advantages for stakeholders in decision processes. Thus, in order to assess standard openness – or any kind of technology openness – the underlying assumption of how knowledge is shared, received and used should guide us. Figure 1 depicts the conceptual framework of how knowledge excludability affects adoption and appropriation, the dilemma of openness and possible implications for the discussion on open standards.

West (2003) suggests that firms tend to develop a hybrid technology strategy using a mix of proprietary and open source, intended to speed adoption while retaining some appropriation opportunities. In this setting open source is regarded as *"the ultimate form of an open standard because implementations are provided freely for all to use"* (West, 2007, p. 89)., This theory is later complemented by the concept of technology revealing, where firms waive rights to parts of their technology – thus turn it into open source – in order to strike a balance between sharing and protection (Henkel, 2006); (Henkel, Schöberl, & Alexy, 2014). These different approaches discuss the implementation and sharing of open standards and source in an *entire value chain*, in all the architectural layers of a technology (West, 2003). Vendors can engage in developing the core technology; complementors – complementing firms – build extensions meant for end-users (West, 2007). The focal firm extracts different benefits from vendors and complementors (Henkel, Schöberl, & Alexy, 2014); (West, 2003). When a wider set of vendors engage in and adopt an available technology the benefits are reliability, lower costs, marketing gains and R&D effectiveness and efficiency. The benefits from having complementors to adopt a technology come from variation for users, and users further adoption. This distinction between vendors and complementors resonates with the supply and demand side in Langlois and Robertson's (1992) seminal article on innovation in modular systems; the supply side benefits from division of labour and rapid learning while the demand side benefits from fine-tuning innovations to consumer needs. Boudreau (2010) implicitly suggest the same distinction. His phenomenon of granting access is in line with the sharing of a platform with demand side complementors; his phenomenon of devolving control is about letting others take part in developing the platform itself – the supply side of the platform. Also Eisenmann et al. (2009) distinguish the supply and demand side, respectively as platform sponsors and application developers. Others discuss openness foremost on the complementor side, assuming that the core technology is in full control (Iansiti & Levien, 2004) ; (Gawer & Cusumano, 2002); (Teece, 1986).

This distinction between standard openness on the supply and demand side differs from the often used dichotomy inbound and outbound innovation (Vahter, Love, & Roper, 2014); (Aslesen & Freel, 2012); (Dahlander & Gann, 2010). For instance, the concept of open inbound innovation implies acquiring ideas and knowledge or source licenses and technologies, more similar to a buyer-seller relationship in a value chain. In Dahlander and Gann's (2010) typology for inbound and outbound innovation, both supply and demand side aspects of standard openness fall into category outbound innovation; their category refers to *"how internal resources are revealed to the external environment"* (Dahlander & Gann, 2010, p. 703). Thus, there is a need for further elaboration on this dimension of openness.

Although the literature discusses both supply and demand side aspects of standard openness, most contributors do not suggest two distinct dimensions. Shilling (2009) suggests only one single continuum for openness; however, she discusses how both the supply and demand sides are involved in the multiple pathways to a dominant design. Neither does West (2007) explicitly distinguish supply from demand side aspects in his detailed suggestions for openness indicators. Instead he calls for research on variability "of openness across technologies, standards and standardization fora to refine classification of the openness dimensions" (2007, p. 115). Responding to the call, this paper uses empirical data on standardization fora in the mobile telecommunication sector to explore how openness of standardization varies along two dimensions: supply and demand side openness. The concepts are elaborated upon in the next section.

3 Empirical context and method

Standard setting bodies and private platforms are the cases for comparison in this paper. These standardization fora are researchable subjects with identifiable outcomes and processes. Standard setting bodies are either officially recognized standard developing organizations or consortia that are not officially recognized. (NO-REST, 2005). Private platforms are firms that provide a technology that becomes a de facto standard. The line between a private platform and consortia with one central player is blurry. Thus, standards can come about through standard wars, or being imposed by a platform leader, large customer or government agency (Farrell & Simcoe, 2012); the organizations and processes involved in the development of standards vary accordingly (Takanashi & Lee, 2013); (West, 2007). Standardization is *"a voluntary process for the development of technical, but more and more also other types of specifications based on consensus amongst the interested parties"* (Blind, 2013, p. 6). In the first instance, standards are shared technical specifications that have public good characteristics. However, it is also recognized that *"a variety of market and nonmarket processes determines the evolution of standards"* (Greenstein & Stango, 2007, p. 1). Thus, in the second instance, there are non-technical aspects of standardization fora that affect public and private goods issues (Takanashi & Lee, 2013); (West, 2007).

This is a comparative case study (George & Bennett, 2005). The cases – standard setting organizations and private platforms – are similar as they somehow provide technical specifications with public goods characteristics; yet they differ along other dimensions. Despite their differences they are chosen because they – from the perspective of mobile network operators – are highly influential on the innovation dynamics in this ecosystem. There are comparative studies on standards setting both in the telecommunication industry (Laffan, 2011); (Funk, 2009); (Edquist, 2003); (Funk & Methe, 2001) and more generally (Takanashi & Lee, 2013); (Jansen & Cusumano, 2013); (Farrell & Simcoe, 2012); (West & O'mahony, 2009) (Schilling, 2009); (Andersen, 2008); (West, 2007). These are important sources, however, do not provide a fully developed evaluation scheme or typology. Thus, this study can be described as analytical, theory-driven induction (George & Bennett, 2005); evaluation criteria are developed and a typology suggested based on the empirical comparison of the cases, supported by theory.

I have collected three types of empirical data. Eight interviews of industry and standardization experts in the incumbent Norwegian mobile network operator guided the research initially, and shed light on the later analysis. The interviewees are on a senior level, participate in standard setting bodies, and work with research, research policy, technology strategy and technology trends. The standard setting organizations' web-sites are the fundament for comparisons and analyses. I have also used available market and actor analyses of the sectors. The self-presentation of the standard setting organizations on their web-sites is a source for failure, however partially balanced by the interview data. It took a lot of "soaking and poking" (George & Bennett, 2005) with theory and empirical data to converge towards a theoretical grounding and develop two concepts and their indicators. The two concepts are different dimensions on openness, respectively supply and demand side standard governance.

3.1 Concept - Supply side standard governance

Supply side standard governance is a concept which assesses how standardization forum involves vendors and other stakeholders in developing and accessing the core of the technology. Table 1 describes the indicators and explains why the indicator is relevant for adoption conditions, and how an indicator can vary. Thus, in the table I seek to include the arguments underlying the discussion of how openness possibly affects conditions for appropriation and adoption conditions. The eleven indicators are implicitly subject to logic of family resemblance; it is not necessary for an indicator to be present in order to categorize the case at the extremes (Goertz, 2005). I denote the extremes for the concept open and closed.

The eleven indicators in Table 1 can be divided into four themes, not mutually independent. The first theme concerns participation, and how different aspects of participation can affect the standardization outcome, for instance participation fees, decision rules and size of participant. The second theme is goals of the standardization body; these are reflected in the three indicators mission, path dependency, and patents. The latter two can be understood as implementations of the missions. The goals signal how the standardization body relate to aspects of appropriation and adoption of the technology specifications. Availability of the standard is a third theme; the patent indicator can be regarded as a part also of this theme. How easy and costly it is to access the technology specification is affecting adoption. Finally, the theme transparency is indicating how easy it is for outsiders to have an opinion about the significance of the standards, and to affect the standardization process and final outcome.

Other studies have suggested similar evaluation criteria for standardization fora, however, only partly serve the purpose of the present study. Takanashi and Lee (2013) even use the term standardization governance mechanisms when describing the process of how standards develop. Their evaluation criteria affect how I set relevant extremes for participation and transparency. Jansen and Cusumano (2013) implicitly suggest the extremes community and private entity in their evaluation of standards, which correspond with the how I use open and closed as extremes for supply side governance. West (2007) provides a rich and well-structured set of openness evaluation criteria for both the standardization processes and their outcome; these are similar to both indicators and extremes suggested in Table 1. However, the empirical induction in this study has led to yet a different set of indicators. This is fully in accordance with West's call (2007, p. 115) to refine classifications through empirical comparison. Additional indicators in Table 1 are details on participation and decision rules, mission path dependency and transparency, while the implication indicator is left out; it did not appear in the empirical induction and will require different data collection.

Table 1 Supply side standard governance indicators

Separating dimension	• *Description of concept* • *Potential relevance for adoption conditions* • *Concept variance*
Membership in SSO and working groups	• Standards in standard setting bodies are developed in groups with individual members. • How easy/controlled it is to become a member on all levels will affect the constitution of such a group, and subsequently the work of the group. • The bodies can vary from totally open to a more restricted membership policy.
Membership fee conditions	• In addition to having restrictions on who can become a member, the standard setting bodies may require a membership fee. • The size of a fee can affect the perceived easiness of becoming a member. • The bodies vary from totally free to a higher membership fee.
Numbers of actors involved	• There are different numbers of actors (firms) involved in the standardization processes. • The number of actors tells about the complexity in a process, and how easy decisions come about. • Numbers can vary from many to one.
Financing	• The financing of the standardization body can tell something about the stakeholders – and financial stakes – of the sector. • This may skew the actions and decisions in the standardization processes. Some standards are financed by the members, which again are commercial actors in the industry. Other standards are financed by interest groups and universities. This latter group may also be subject to commercial interests, but in more intricate ways.

Effect of large organizations	• Idealistic versus commercial interests. • The effect of large – and commercial – firms concerns those who believe that knowledge and ability to make good decisions (for the standards) are equally distributed among independent individuals. • Commercial actors would – as an obligation to their owners – seek to arrange perceived good solutions for the owners. Others will hold that ability to change and innovation for the customers and society – and eventually the commercial companies – is better taken care of by competent individuals. • Some standard setting bodies seem to be highly affected by large organizations, while others mainly consist of independent individuals.
Decisions and voting	• The development of standards involves decisions on how to proceed and finalize a standard. Initiation, governance, completion and decisions on standard specifications are all aspects of this process. • It leaves room for different conclusions, and different effect on market performance. • The standard setting bodies are different with regards to process as well as voting.
Mission	• The mission is a statement of overall motivation for the standard setting bodies, what it wants to achieve; standards and technology as public or private good is implicit here. • If the actual standards adhere to the mission they could affect the overall market performance to develop in different directions. • Missions seem to be both very technically oriented, industry oriented or more idealistic.
Path dependency	• Path dependency is the tendency for standard setting bodies to make choices that are affected by existing decisions, knowledge, processes, investments, etc. In the case of standard setting bodies, existing standards could potentially highly affect choices. • The concept of path dependency is recognized to affect performance both positively and negatively. On the one hand path dependence ensures scale, critical mass, deep insight, efficiency and other elements that serve the users. On the other hand path dependency decreases the ability to necessary change. • The standard setting bodies vary from being path dependent by declaring backwards compatibility, to claiming pure technological functionality.
Patents	• Standards are consensus on specifications, but can include patents held by private parts. • Patents ensure compensation for Intellectual Property Rights, and affect the cost of using the standard in the first instance and potentially performance in second instance. • Standard setting bodies vary from trying to reach a royalty free state, to having a FRAND policy for patents; FRAND means patents licensing on Fair, Reasonable and Non-Discriminatory terms.
Availability of standards	• Standards are described in (digital) documents provided by the standard setting bodies. • Less available standards – or a high price – could imply to exclude users, or a less efficient diffusion of standards. In this way access to standards can affect performance in several ways. • More or less available standards.
Transparency	• In the above listing of variables we have illustrated how standard setting bodies can differ, and affect performance through actions. • Actions can be subject to external judgements, and be perceived negative by others. Transparency ensures that it is easier for the external environment to affect standard setting bodies – for good or bad – based on facts rather than suspicion. • More or less transparent.

The “soaking and poking" with theory and empirical data in this study led to the conclusion that one indicator had to be treated separately: the practice of sharing platform with complementors through interfaces. West (2007) incorporates most aspects of this indicator in his evaluation criteria for standard openness, however, does not elaborate on how it distinguishes from the others. In the present study the indicator turned out to be a standalone concept which did not co-vary with the other indicators, and also served as an important differentiator between the cases.

3.2 Concept - Demand side standard governance

The concept demand side standard governance assesses how the standardization fora open the technology to complementors on the demand side. Complementors get access to elements of technology through APIs. Such interfaces have been the normal way to achieve compatibility with external applications (West, 2007); (West & Dedrick, 2000) and they can be provided in extension markets (Jansen & Cusumano, 2013). These form of market constellations are often denoted as industry platforms (Gawer & Cusumano, 2002) or ecosystems (Iansiti & Levien, 2004). Apple, Google and W3C have been assessed as platforms with extension markets (Visionmobile, 2014). SMS Application-to-Person is an example of extension market for mobile network operators (Hallingby, Forthcoming). Standardization fora can be characterized by having more or less open APIs to complementors, more or less sophisticated implementations of extension markets (Jansen & Cusumano, 2013), and size of developer communities (West, 2003). How these aspects are managed could affect the openness of a technology. Indicators of the concept demand side standard governance with the extremes open and closed and described in Table 2.

Table 2 Demand side standard governance indicators

Separating indicator	• *Description of concept* • *Potential relevance for adoption conditions* • *Concept variance*
APIs towards complementors	• Complementors or developers are dependent on having access to the technology through a technology interface in order to develop extensions • Availability and interface ease-of-use can affect innovation with the technology • Interfaces can vary from unavailable to easy to access and use
Extension market	• Standardization fora can enable access to and purchases of additional innovations/complements through dedicated market places – extension markets • Purchases through extensions markets can reduce risk and increase demand for complementors • Extension markets can be more or less sophisticated, accessible and costly to join, and subject to more or less commercial purposes from the owners
Complementor community	• Standardization fora can have complementors using their technology to develop extensions • The number of complementors can be a sign of how the standardization forum has succeeded in engaging others to innovate with their technology • Complementor communities can vary from small to large

4 Case description

The cases drawn for comparison are either standard setting organizations or private platforms that provide standards (West, 2007); they are relevant to compare since mobile network operators perceive them as highly influential in the telecommunication ecosystem and also choose to participate in the standard setting organizations that are analyzed. The standard setting organizations are ETSI, 3GPP, 3WC and IETF, and the private platforms are Google and Apple. ETSI, 3GPP, 3WC and IETF set standards for respectively telecommunication in general, mobile telecommunication, the Web and Internet. They have often been put in the same category and treated as equivalent (Farrell & Simcoe, 2012), but are very different with regards to practices of sharing and control of technology.

ETSI and 3GPP belong to the regime of industry-led standard setting fora in the mobile telecommunication sector. 3GPP (3rd Generation Partnership Project) covers mobile (cellular) telecommunication network technologies. 3GPP is governed and financed by seven different telecommunication standard development organizations. It recruits its participants from it financing sponsors, for instance ETSI.

ETSI is the EU recognized European Telecommunications Standards Institute, and produces standards for the wider information and communication sector. Its members are paying firms in the industry, as well as academic and public institutions. Larger commercial firms have to pay the most for being members. The participants in the standardization processes are recruited from the members.

3WC and IETF are bodies that are run by communities of volunteers, initiated and supported by influential stakeholders. 3WC (World Wide Web Community) is (still) led by the Tim Berners-Lee, the inventor of the web. It has the mission to lead to the World Wide Web to its full potential by developing protocols and guidelines that ensure the long-term growth of the Web. 3WC is financed by membership fees (50%) and funders. It adheres to open standard principles that will fuel development of new technologies and innovations for humanity. 3WC affect the mobile telecommunication industry by providing significant standards for accessing services on mobile devices.

IETF (Internet Engineering Task Force) is an open community which is concerned with the evolution of the Internet architecture and operation. It develops the Internet standards through open working groups. It is financed by The Internet society, a professional membership organization of Internet experts. IETF provides standards that have highly affected data traffic technologies, traffic management and data interconnection in the mobile industry.

The final type of standardization forum is the private platform. Apple and Google are examples which control respectively iOS and Android. These are private companies that have succeeded in establishing their technologies as crucial platforms in the mobile telecommunication industry, both as operating systems for devices and platforms for user applications.

5 Results and analyses

5.1 Supply side standard governance

The extant literature and industry discussion are focussed on openness as the important differentiator between standards and technologies (Boudreau, 2010); (Schilling, 2009); (West, 2007); (Henkel, 2006); (Gawer & Cusumano, 2002). Looking only at the empirical data, the first impression is that commercial interest is the most noticeable difference between the standardization fora compared in Table 3; there is a strong tension between creating and protecting existing markets versus a more idealistic perspective toward creation of good technological solutions and ensuring innovation. For those with commercial motives governance of standards according to openness becomes a method to balance creation and capturing of value. Therefore I choose to keep open and closed as extremes for the concept, also reflecting the non-commercial and commercial aspects.

Table 3 Standardization for a according to indicators for supply side standard governance

Separating indicator	*W3C*	*IETF*	*3GPP*	*ETSI*	*Google*	*Apple*
What is this?	Web	Internet	Mobile	Telecom	Private platform	Private platform

Separating indicator	*W3C*	*IETF*	*3GPP*	*ETSI*	*Google*	*Apple*
Standards developed	HTML5	TCP-IP	GSM, 3G, 4G	e.g. DECT, TETRA (GSM)	Android	iOS
Membership in fora and working groups	Individual. Organizations must apply for individual membership.	Individual. Completely open. Cannot participate on behalf of organization.	Seven partner members. Membership organization assign individual.	Organization members. Membership organization assign individual.	Private. Open source project where others can contribute on core code – highly controlled by Google.	Private. Some use of open source in Mac OS X (and for developers e.g. WebKit).
Membership fee conditions	Organizations pay fee, dependent on size, type and country.	No membership fee, fee for participating in meetings.	Membership organization has paid, e.g. ETSI	Membership fee, vary with size. E.g. universities have low fee.	No membership fee in order to contribute code on supply side (to our knowledge).	Private, not relevant on supply side.
Number of actors involved in standard development	Many actors (operators, HW, universities)	Many actors (content, operators, HW, SW, universities)	Many actors (content, operators, HW, SW, universities)	Many actors (content, operators, HW, SW, universities)	Restricted. A few chosen partners involved in developing private code branch.	One central player
Financing	Funders and donators. Membership fees (>50%)	Internet society	Membership organizations, e.g. ETSI. Some are larger contributors	Membership fee	Privately financed. Contributors to code finance themselves.	Privately financed on commercial terms.
Effect of large organizations	All members/individuals equal – one vote	All individuals equal	Larger organizations have more voting power	Larger organizations have more voting power	Google has full control	Apple has full control
Mission	Innovation to the best of society	Technology concerns. Running code.	Ensure progress, backwards compatibility.	Deliver world-class standards for ICT, ensuring sustainable future	Google's private missions: growing audience for advertising on the mobile. Android's purpose is to establish an open platform for developers to build innovative apps.	Private missions
Suggestions, decisions and voting	People generate interests in particular topics. Consensus decisions. Moderator plays important role. Can vote – one individual has one vote.	Anyone suggest, engage others. Consensus decisions. Moderator plays important role.	Suggestions need support from other members. Consensus decisions. When voting, larger organizations have more votes.	Technical bodies establish and maintain work programme. Consensus decisions. When voting, larger organizations have more votes.	Suggestions for code can come from contributors. Google in full control of evaluation and decisions.	Private
Patents	Prefer royalty free standards	Prefer royalty free standards. Accept patents on terms that are Fair, Reasonable and	Accept patents on terms that are Fair, Reasonable and Non-Discriminatory[1]	Accept patents on terms that are Fair, Reasonable and Non-Discriminatory[2].	All rights are given up to the Android open source project. In general Google use patents actively to protect	Use patents actively to protect technology[3].

[1] *The electronic and hardware industry providing components in the telecommunication market hold many US patents (IFI Claims Patent services, 2014), for instance Samsung, Sony, Qualcomm, LG, Intel, Ericsson and AT&T.*

Separating indicator	*W3C*	*IETF*	*3GPP*	*ETSI*	*Google*	*Apple*
		Non-Discriminatory			technology[3].	
Availability of standards	Freely available on web-sites	Freely available on web-sites. Patents restrict use.	Freely available on web-sites. Patents restrict use.	Freely available on web-sites. Patents restrict use.	Tightly controlled by Google, with tests and compatibility criteria for users.	Not available, proprietary technology. Use Open source tactically to develop core platform.
Transparency	Fully transparent	Fully transparent	Regarded fair, transparent and efficient.	Regarded fair, transparent and efficient.	No insight in private code, roadmaps or decisions.	Not transparent
Path dependency			Backwards compatibility important			
Important websites and sources	w3c.org	ietf.org	3gpp.org	etsi.org	google.com/about, source.android.com	apple.com/about

Figure 2 shows the concept supply side standard governance as a horizontal continuum, and how I have assessed the cases. The figure also contains a high-level description of the criteria used to assess the cases. 3GPP is a standard setting organization for the mobile industry with seven governing and financing partners from the telecommunication standardization sector. Members of these partners – e.g. ETSI – have the right to participate in 3GPP standardization committees. For ETSI the membership fee vary with size of the organization, for instance will universities have a low fee. Many actors take part in the ETSI standardization efforts, but are dependent on the partner membership requirements. 3GPP communicates a clear ambition of backward compatibility in order to ensure that user equipment is un-interrupted; continuity and stability is important. Backward compatibility is held to be rooted in technological functionality. Nevertheless, it still signals a high level of commercial ambitions for 3GPP, and high degree of self-imposed path dependency. The standardization process is open and standards are released on a website, however only four times a year; the insight coming from tacit knowledge and the controlled releases of specification leaves the participants with a potential knowledge advantage. Patents within standards are restricted, however, accepted on terms that are fair, reasonable and non-discriminatory. The balance between the need for standards and profit is reflected in what one expert says: *"The goal with standards is to reach a minimum for things to function […] Things have to be interoperable. But you have to open for competition – otherwise all are identical – there is no more business, right?"*

[2] *Ibid.*

[3] *Google and Apple score high on several assessments of their patent activity, both regarding patent power (Thomas & Breitzman, 2013) and number of US patents (IFI Claims Patent services, 2014)*

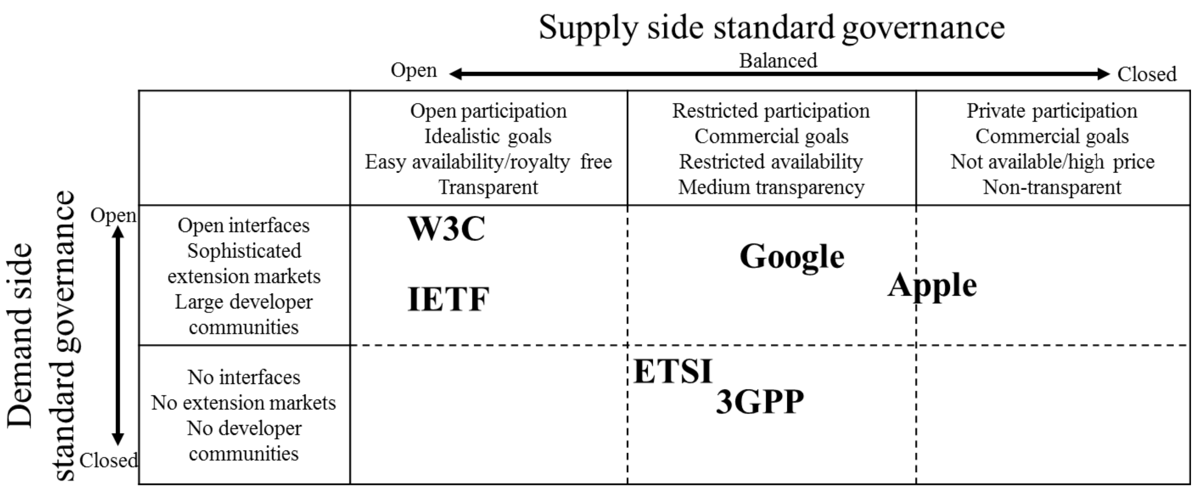

Figure 2 Assessment of standards according to Standard governance and Extension markets

Melody (2013) describes standard setting organizations such as 3GPP as open standard bodies. However, this is compared to private platforms with heavy use of IPR. In the present study 3GPP is evaluated closed in the sense that the participants are recruited from the mobile industry, and participation thresholds and costs are higher. Furthermore, the process of suggesting new topics is more formalized and connected to the membership status. The missions are clearly commercial to the best of those that already are stakeholders, for instance with backward compatibility. However, they produce technological specifications that are accessible for others. One telecom expert explains that arguments and decisions shall not be commercially based: *"You cannot sit there and argue that you have hundreds of millions of subscribers. Arguments shall be based on technologically reasonable solutions. It implies that in discussions you have technical arguments, however, there are always underlying commercial arguments"*. And regarding decisions: *"Eventually, size is important. Who are you? If you are a small actor in the world market you are less influential even though you in theory should be equal to all others"*. Standards are currently a self-imposed regime, however based in historic political processes where standards for fundamental infrastructure have been imposed to the best of society. Although 3GPP in some ways is an open and fair standardization process it is controlling the process through its participation rules and backward compatibility requirements. On a continuum for supply side standard governance it is positioned in the middle, balancing between open and closed as illustrated in Figure 2.

ETSI is in most instances governed by many of the same principles as 3GPP. It is easier to become a direct member of ETSI, however still subject to a fee. Likewise, the requirementson backward compatibility are less strict. Still, I regard the traditional standard setting organizations in the mobile industry – ETSI and 3GPP – not to be fully open, neither closed.

Apple and Google are positioned even nearer the close end of the horizontal continuum in Figure 2. According to Melody these actors are closed, playing a game of secrecy and patents (Melody, 2013). They have mainly commercial goals with high stakeholder expectations to current and future returns. Apple is often denoted as proprietary with tight control of its iOS platform and production of its own devices (Laffan, 2011); (Boudreau, 2010); (Eisenmann, Parker, & Alstyne, 2009) One interviewee comment the position of Apple with the following: *"Apple – their iOS – they are deciding. Full stop. It is proprietary"*. However, Apple uses open source code strategically to develop its core technology Mac OS X and in the interfaces towards complementors, e.g. WebKit (West & Mace, 2010); (West, 2003). I consider Apple to be closed, but not fully closed.

Google, and the mobile platform Android is more often evaluated to be an open platform (Grøtnes, 2008), applied across many device vendors. However, according to Laffan (2011) Android is the most closed open source project in the mobile sector. She concludes that while seeming open through its use of open source technology and engaging vendor side development of Android, Google uses its governance of code to keep a tight control of the result. Firms can contribute to the code, but evaluation and decisions are made by Google. Google also carry out a closed and parallel development of code, with delayed releases to the public code. Those vendors who want to use the released open source code have to apply for and fulfil Google's compatibility requirements. Google communicates that the purpose of Android is to establish an open platform for application developers, and Google promotes the advantages of being able to support all complementing developers across vendors. Still, Google Play – the marketplace for complementing developers – is fully proprietary software which the vendor side has to license from Google. Google seems to strategically balance open and closed for commercial purposes; the fact that it extract its revenues from search and advertising is an additional explanation for why Google practise openness with the Android platform (Laffan, 2012); (Grøtnes, 2008).

In sum, considering both the traditional telecommunication standard setting organizations and private platforms, they are neither open nor completely closed. This is depicted in Figure 2. They take actions to partly open their standards to others, as far as it is beneficial to them. Google and Apple are using open source towards the supply side; 3GPP and ETSI involve many actors in the development of the standard specifications.

I regard supply sided standard governance to be open for IETF and W3C. These fora are the providers of respectively Internet and web standards, and represent more idealistic stakeholders such as Internet society and Tim Berners-Lee. IETF adheres to technological performance; W3C provides standards on a very idealistic basis with open innovation to the best of society, and technical merit and sharing as important values. The output of the standardization process is available on the web, free of charge. Their policies are clearly royalty-free licensing, however, with guidelines in order to handle IPR issues. The participants in the communities both IETF and W3C are individuals. IETF is completely open to newcomers, but does not accept them as company representatives. However, IETF admits in a problem statement on its organization, that these principles are challenged by concentration of influence and larger firms' higher financial allowance for participation (Davies, 2004). IETF does not have membership fees, while participants must pay for taking part in meetings. In W3C organizations apply for membership on behalf of the individual, and can become a member as long as it signs the membership agreement and thus surrender IP rights. Individuals can apply. Membership in W3C is subject to a fee, dependent on type of organization, size and headquarters. In both IETF and W3C new standards are suggested by individuals who get other people interested in a topic and next persuade them to join a working group. It is then an administrative leader that accepts the new topic. A completed standard is reached by consensus in the working groups. IETF practise rough consensus: an agreement is reached when the chair perceive that there is a large enough majority. In W3C it can come to voting for substantial issues and each organization has a vote. A final decision can be made by the Director heading W3C. One expert explains that even the current director is influential in principal, it is the Advisory Board that defines work and decision processes in W3C; the Advisory Board is appointed by the Advisory Committee where all members have one representative. The process appears democratic bottom-up. However, a result cannot always be reached and there are people appointed to facilitate the process. Chairs and directors on different levels will have some influence on the process. Thus, there are governance issues also for IETF and W3C that restrict their openness. Still, in the continuum used for supply side standard governance they are considered as open.

5.2 Demand side standard governance

Demand side openness is a significant differentiator between cases. The cases are evaluated according to technology interfaces, extension markets, and complementors' community size. Open and closed are high-level extremes of this continuum, depicted in Figure 2. Private platforms – for instance Google and Apple – differ significantly from 3GPP and ETSI with their openness towards complementors, sophisticated and commercial extension markets (Jansen & Cusumano, 2013), and large complementor communities (Visionmobile, 2014). Based on the current status I assess Apple and Google as similarly open; however, Apple often has been regarded as keeping tighter control over its complementors (Eisenmann, Parker, & Alstyne, 2009) and also requires a fee (Jansen & Cusumano, 2013).

Mobile operators are implementers of demand side aspects of the traditional telecommunication standardization fora ETSI and 3GPP. GSMA – which represents mobile operators – has discussed demand side openness and extension markets through standardized APIs. Nevertheless, according to GSMA (2014) mobile network operators have not succeeded. The analyst Alan Quayle (2014) observes that mobile network operators partly do not provide APIs towards complementors and partly do not succeed with such initiatives. The failure of such trials can be rooted in challenges with shared ownership of platforms (West & Wood, 2013) which characterize competitive mobile markets. In Figure 2 I have positioned the Google and Apple, and 3GPP and ETSI on opposite extremes on the vertical dimension for demand side governance.

W3C is completely open also on the demand side, providing a different, but widely used and freely available extension market (Visionmobile, 2014); HTML5 is both a public standard and recognized as providing an extension market with a large developer community. IETF is seldom presented as having an explicit extension market, however Gawer (2009) denotes IETF as a typical platform. I therefore position IETF alongside W3C as open, however recognizing that the lack of sophisticated market for extensions moderates the openness.

6 Discussion

The evaluation of the cases according to supply and demand side standard governance reveals that they take different patterns along the two dimensions. This implies that the extremes open and closed of demands side standard governance can be combined with either of the extremes of supply side standard governance. The combination of the scores for the different standardization fora depicted in Figure 2 builds a typology of different configurations. The cases assessed in this paper fall into three different types, with Apple almost over in the fourth type with proprietary supply side standard governance. The configurations can be seen as merely a snapshot of the current mobile telecommunication ecosystem or used to discuss strategic opportunities by shifting configuration. A move along the continuums can be motivated by the need to affect appropriability and adoption conditions; thus, an assessment of how the cases score on these conditions can shed light on the types' attractiveness.

6.1 How is the standard governance typology related to innovation and profits

As explained above firms can extract different benefits from openness on the supply and demand side standard governance. The traditional mobile telecommunication industry – here represented by the standard setting organizations ETSI and 3GPP – practice a balanced openness on the supply side and are closed on the demand side. These standardization fora have succeeded in engaging the supply side in the development of the technologies and reached benefits such as cross market functionality and lower cost through competition and scale advantages. One telecom expert says: *"Global markets provide the opportunity to build mass market with economies of scale. We get lower prices for the operators and users. It also gives service compatibility across nations."* The division of labour has allowed specialization; the vendors develop and produce the technology, and the mobile network operators purchase and operate it. Another expert explains how the growth of vendor newcomers such as the Chinese Huawei, competing with incumbents like Ericsson, is a sign of an open market access on the supply side. This is in line with ETSI's (2015) argumentation that standards are important in order to open market access, economies of scale, technical awareness and innovation. Contrasting this, ETSI and 3GPP are considered closed on the demand side. This is confirmed by GSMA that – on behalf of mobile network operators – recently reported revenue stagnation along with an inability to create necessary variety and innovation among complements (GSMA, 2014). Fortune (2015) documents how the mobile operators' financial performance lags behind in the US; in Europe both the operator and vendor side stagnate (EuropeanCommision, 2012).

The Web and Internet – based on the 3WC and IETF standardization efforts – are open both on the supply and demand side of standardization governance. The Web sector is perceived as dynamic, however, the revenue level for firms in the sector in Europe is low (EuropeanCommision, 2012). Likewise, Internet – based on the IETF standardization efforts – is regarded as creating tremendous variation, but less direct value capturing. This weak ability to extract revenues and profit reflects – as expected – the public good characteristics of the standards. Internet and the Web have *"created a variety of new business opportunities and ways to make money"* (Cusumano & Goeldi, 2013, p. 39), however *"taking money from these new business models has been difficult"* (Cusumano & Goeldi, 2013, p. 242). Cusumano and Goeldi hold that instead of generating direct revenues from Internet and the Web technologies, we often see that value is captured indirectly through enhancing existing business models (online sale) substituting existing business (travel agencies and book retailers), or totally new businesses (Internet portals such as Facebook) (Cusumano & Goeldi, 2013). In addition, the specifications coming from IETF has indirectly been highly important for all types of network technology for the two last decades, contributing to supply side innovation and lower costs, for instance IP-based mobile LTE (4G) (3GPP, 2015).

The private platforms Google and Apple are assessed to be balanced on supply side, and open on the demand side of standard governance. Fortune 500 (2015) documents their financial success as individual companies with high revenues, profit and growth. They have a dynamic ecosystem on the demand side in the mobile sector with high degree of innovation among their complementing developers in the mobile sector (Visionmobile, 2014).

Table 4 Summary of standard governance, appropriability and adoption assessment

	Standard governance	*Adoption ability*	*Appropriability ability*
W3C & IETF	Supply side: Open Demand side: Open	Supply side: Strong Demand side: Strong	Weak
3GPP, ETSI	Supply side: Balanced Demand side: Closed	Supply side: Satisfying Demand side: Weak	Weak(ening)
Private platforms Apple and Google	Supply side: Balanced Demand side: Open	Supply side: Satisfying Demand side: Strong	Strong

Table 4 is a high-level assessment of the cases according to supply and demand side standard governance, and further, appropriation and adoption condition. The extremes for the latter two conditions are strong and weak. The practises with balanced supply side standard governance is reflected in what I denote a satisfying level of adoption ability on the supply side, contrasting the strong supply side adoption for W3C and IETF. W3C and IETF adoption abilities are strong on both the demand and supply side standard governance, while appropriation abilities are weak. Google and Apple combine strong adoption ability on the demand side with satisfying supply side adoption ability; they have strong appropriation abilities. ETSI and 3GPP have satisfying adoption on the supply side standard governance, but are weak on the demand side. The traditional mobile sector – with the mobile network operators and their vendors - has weak appropriation abilities.

Although only an indication, the analysis implies that open demand side standard governance is sufficient condition for reaching complementor adoption, as we see it for respectively private platforms, and 3WC and IETF. However, it is necessary with balanced or even closed supply standard governance to control resources with some degree of private goods characteristics in order to extract profit, as in the case for Private platforms. Hussinger and Schwiebacher (2015) affirm this necessity of remaining some private goods characteristics of technology contributions to open standards in order to perform better; likewise, Aksoy-Yurdagul (2015) finds that firm cannot achieve returns from commercializing open source software – the ultimate open standard – without other proprietary revenue sources.

The 3GPP and ETSI cases with balanced standard governance are not (anymore) sufficient to provide the mobile network operators and their peers with profitable conditions. Open demand side standard governance is necessary to grow and sustain, as we observe for private platforms. The results suggest how to balance technology openness and adoption with profit in the market. It is indicated that the networked and complex telecommunication market currently requires more involvement on the demand side in order to extract profits. The results from this study cannot predict the configuration that leads to future commercial success, however, serve as a tool to structure strategic discussions and actions.

The analysis indicates a causal link from types to adoption and appropriation conditions. However, the causal relationships could go both ways and strong appropriation condition and financial success could leads to more openness. West (2003) reports how this has happened with platforms; already successful proprietary platforms start to use more open source software (West, 2003). Likewise, the telecommunication sector was subject to, and took advantage of the enforced standardization that was part of the deregulation of national monopolies (Melody, 2013). This does not change the current status of how standard governance is associated with strong adoption and appropriation conditions, however, opens for a discussion on the optimal standard governance combination.

7 Conclusion

This paper reports whether important standardization fora in the mobile ecosystem are open or closed. It suggests two concepts and belonging criteria for assessing the fora: supply and demand side standard governance with the extremes open and closed. The analytic comparison of six cases leads to a typology which is the foundation for a discussion on adoption and appropriation conditions. 3WC and IETF are open both on demand and supply side standard governance; there are strong adoption conditions, while appropriability conditions are weaker. Google and Apple combine balanced or rather closed supply side with open demand side standard governance; they seem to balance strong appropriation abilities with adoption among vendors and especially complementors. 3GPP and ETSI adhere to balanced supply side standardization governance and closed demand side governance; they do not achieve adoption on the complementor side and currently experience weak appropriation.

The types suggested in the paper serve as strategic directions for profit seeking firms that aspire to get their technology widely used while still extracting profit. More specifically, it is suggested that open demand side standard governance is a necessity in order to reach stronger appropriation in the current telecommunication ecosystem. The principal nature of the analytic framework contributes to the debate on technology openness and appropriation and adoption conditions in complex, networked markets.

The limitation of the results is primarily the generalizability to other cases, circumstances or point of times. However, this was hardly the ambition of the analysis. Instead, the research has resulted in a systematic typology that serves as a foundation for new hypotheses and enables a test of other cases against it. Further work could systematically identify and investigate all theoretic types in order to refine both the typology, and to elaborate on how combinations of open and closed supply and demand side standard governance affect adoption and appropriation conditions.

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The Multi-Dimensional Nature of Standardisation in Support of Innovation: A Systematic Analysis of the History of Photovoltaic Technology

Jae-Yun Ho, Eoin O'Sullivan

University of Cambridge
jyh25|eo252@cam.ac.uk

Abstract: *Despite increasing awareness of the critical role of standards in technological innovation, there remain significant challenges to managing standardisation activities in a timely and effective manner. This is due to limited understandings of complex dynamics between standardisation and innovation; different types of standards, developed by different sets of innovation actors, support a variety of innovation activities, at different stages of technological and industrial lifecycles. In order to overcome these challenges, recent theory-building efforts have led to the development of a novel systematic framework which carefully articulates and characterises important dimensions of standardisation in the context of technological innovation. Testing and building on this framework, this paper presents a systematic analysis of the history of photovoltaic (PV) technology and relevant standardisation. This case study not only demonstrates the importance of the multi-dimensional nature of standardisation in understanding how they support innovation, but also identifies a number of interesting patterns and trends, increasing our understandings of complex dynamics between standardisation and innovation. In addition, the case study provides additional insights for minor improvements of the framework itself. Capturing important aspects and issues to be considered for strategic management of standardisation, the refined framework is expected to support standards organisations and policymakers for more systematic and future-oriented analyses of standardisation in support of overall technological innovation.*

1 Introduction

With the prevalence of innovation system perspectives, standards have been increasingly recognised as important institutions that underpin technological innovation by disseminating new ideas and transferring useful knowledge (CIE, 2006; Hawkins, 1995). Several recent studies have thus explored various roles of standards in supporting innovation, including: defining and establishing common foundations upon which innovative technology may be developed; codifying and diffusing state of the art technology; and allowing interoperability between and across products and systems (Allen & Sriram, 2000; Blind & Gauch, 2009; Swann, 2010; Tassey, 2000). Recognising such critical roles, many countries increasingly adopt policy initiatives for effective standardisation of key technologies, in order to secure national competitiveness and support their innovation systems (Biddle et al., 2012; Lord Heseltine, 2012; White House, 2011).

Due to the dual nature of standards, however, strategic management for careful planning and implementation of standards is critical in supporting technological innovation more effectively. A standard that is imposed too early hinders diversity and precludes entrepreneurial experiences, closing opportunities for further technological improvement and promising innovation; whereas a standard that comes too late may not only retard achieving economies of scale for new market development, but also result in unnecessary costs of duplication and market confusion, both of which are potentially detrimental to innovation (CIE, 2006; Foray, 1998). Inappropriate standards may also have negative impacts on innovation, such as risks of monopoly and problems of lock-ins into inferior standards (CIE, 2006). Hence, there are needs for more future-oriented analyses to anticipate standards needs and develop standardisation strategies, in order to better support innovation of emerging technologies (European Commission, 2011; Scapolo et al., 2013).

Despite such increasing importance of strategic foresight and management of standardisation at a public policy level, there are limited understandings and academic literature on anticipation and strategy development for standardisation in broader innovation systems. Such limited knowledge is probably due to not only the complex and uncertain nature of technological innovation systems, but also variations and confusions that are prevalent with standardisation. There are actually various definitions of standards used in different ways in different contexts, depending on purposes and interests identified by different parties (de Vries, 1999). In fact, there are various types of standards playing different roles, associated with varying levels of technical details, and developed by a variety of stakeholders with different interests (Allen & Sriram, 2000; Blind, Gauch, & Hawkins, 2010; Sherif, 2001; Swann, 2010; Tassey, 2000). These complexities are further complicated by the fact that they not only interact with each other, but also evolve over time as innovation progresses. Such varieties and complexities involved in standardisation can be also observed from inconsistent classifications on important dimensions and aspects of standardisation in existing literature (e.g. Verman 1973; Branscomb & Kahin 1995; Baskin et al. 1998). Hence, it is extremely challenging to characterise and understand complex dynamics between standardisation and innovation, which are critical information for strategic management of standardisation.

The challenge with effective management of standardisation in support of innovation is becoming even more significant with the recent trend in modern technology-based industries that are interdisciplinary, integrated, and rapidly evolving at the same time. The increasing complexity of modern industries due to their systems characteristic requires a large infrastructure of standards that allow integration of various domains with different technology bases (NPE, 2012; Tassey, 2015). The growing importance of Information and Communications Technology (ICT) in many areas – including smart grid and internet of things, just to name a few – also presents significant challenges of anticipating future standards needs to ensure compatibility and interoperability, especially during earlier stages of innovation with high uncertainties and risks (Biddle et al., 2012; Ernst, 2009). In addition, there are demands for more timely and efficient standardisation activities that respond rapidly to evolving technical needs, in order to gain competitive advantage in the fast changing global landscape and economic environment (European Commission, 2011).

In order to address these challenges, there have been a number of academic efforts to develop a systematic framework for more effective and future-oriented analyses of complex dynamics between standardisation and innovation (Egyedi, 1996; Featherston, Ho, Brévignon-Dodin, & O'Sullivan, 2016; Ho & O'Sullivan, 2015a). Verifying and building on these frameworks, the current research presents a historical case study of photovoltaic (PV) technology. By taking a multi-dimensional approach to analyse how standards support PV innovation, this case study illustrates various dimensions of standardisation, demonstrating their importance for strategic standardisation. In addition, the case study not only increases our understandings of standardisation dynamics in the context of innovation, but also provides additional insights for further refinements of existing frameworks. With more careful articulation and characterisation of critical aspects associated with standardisation, the improved framework is expected to help standards organisations and policymakers make more informed decisions, ensuring effective management of standardisation in support of their innovation systems.

2 Existing Frameworks for Systematic Analyses of Standardisation

Despite increasing awareness of their important roles in supporting innovation, previous academic research on standards and standardisation in the context of technological innovation are limited, generally focusing on a particular technical discipline or a specific standard item (Cargill, 1995; de Vries, 2001). They also have narrow views on standards, addressing certain aspects of standardisation only, usually economic perspectives (Branscomb & Kahin, 1995; de Vries, 2001; Hawkins, 1995). From a systematic review of papers on technology standards, Narayanan & Chen (2012) observe that scholars adopt divergent perspectives with different levels of analysis and different ontological assumptions, yet are confined within a single perspective rather than taking multiple perspectives. Lyytinen et al. (2008) also identify four broad theoretical perspectives adopted in existing literature on ICT standardisation: economic and management theories, legal and public policy studies, social theories, and standardisation practice. Hence, there are fragmented bodies of literature exploring standardisation in various disciplines adopting different perspectives (Choi, Lee, & Sung, 2011; de Vries, 1999).

Consequently, existing frameworks presented in previous academic research provide only partial pictures of standardisation in the context of innovation, focusing on different aspects. For example, Tassey (2000) proposes a framework representing various types of standards used in different industrial activities – including R&D, production, and market penetration – for efficient development and utilisation of technology. Sherif (2001), on the other hand, proposes a framework relating different categories and roles of standards with technology lifecycles – often referred to as S-curve – in the context of ICT. A more recent framework is developed by Blind & Gauch (2009), showing various roles and functions of standards at different stages of innovation processes. Emphasising different aspects of standardisation in the context of innovation, such lack of holistic and integrated perspective results in fragmented and limited understandings of overall dynamics between them.

In fact, there is a high degree of complexity and diversity in various aspects of standardisation, all interacting with each other. There are various forms of standards, each playing different roles and functions, associated with varying levels of technical details, and developed by a diverse mix of stakeholders, all of which evolve over time along with technology lifecycles (Allen & Sriram, 2000; Blind & Gauch, 2009; CIE, 2006; Sherif, 2001; Swann, 2010; Tassey, 2015). For example, in a rapidly evolving field of nanotechnology, there are various standards developed by a variety of organisations, each addressing different issues and interacting with different aspects of innovation (Murashov & Howard, 2011). From our preliminary studies to explore standardisation of PV technology, empirical evidence also suggests that different types of standards with different roles and functions, developed by different Standards Developing Organisations (SDOs) engaging different set of stakeholders, emerge across different stages of innovation (Ho & O'Sullivan, 2013, 2015b). Due to such varieties and complex dynamics involved in standardisation, slight variations may produce very different results, so increasing uncertainties in anticipating, or even analysing, what impacts they have on innovation.

A holistic and integrative approach accounting for various aspects of standardisation utilising multiple perspectives is thus called for, in order to analyse the complex problem of standardisation in the context of innovation in a more comprehensive way (Bonino & Spring, 1999; Narayanan & Chen, 2012). By addressing complexities and varieties involved in both standardisation and technological innovation, a number of scholars have recently taken broader and more integrated approaches. Identifying standardisation as a context of technology development, Egyedi (1996) presents a coherent and comprehensive view on standardisation by adopting the three social constructivist perspectives: institutional, political, and socio-cognitive perspectives. Recognising needs to treat standardisation in its entirety, Garcia et al. (2005) employ the notion of organisational fields to adequately assess impacts and characterise its relationships with other innovation activities. {Formatting Citation}, on the other hand, adopt a technology roadmapping approach in developing a framework for supporting the anticipation of standards to inform emerging technology strategies.

Providing a coherent, holistic, and high-level integrated view of complex systems, while displaying the interactions between technologies and other aspects of innovation over time, technology roadmap-based frameworks appear particularly useful in analysing complex dynamics between standardisation and innovation (Groenveld, 2007; Kostoff & Schaller, 2001; Phaal, Farrukh, & Probert, 2010; Popper, 2008). Featherston et al. (2016) suggest that as one of the most widely used foresight tools, the roadmap-based framework can be also used to inform the development of standardisation strategies, as its process – which brings together various stakeholders to build consensus and create a common vision among them (Amer & Daim, 2010; Groenveld, 2007; Popper, 2008) – is similar to the process of standardisation. By carefully identifying key activities in the innovation process and linking them with associated standardisation opportunities, their framework helps identify where standards may support knowledge diffusion and mediate innovation actors. In particular, the framework identifies a number of important factors of standardisation – including technological activities, types of standards, timing of standardisation, and SDOs and participants involved in standardisation – with special attentions paid to different categories of technologies involved in innovation. However, it is not a coherent and complete list of all critical factors and characteristics of standardisation related to technological innovation; for instance, factors such as types of deliverables or forms of specifications, are not included.

Ho & O'Sullivan (2015a) present a more systematic and refined roadmap-based framework that is grounded on theoretical analyses, through a comprehensive review of literature on various aspects of standardisation. Using an analytical framework consisting of six questions that are often used to describe any forms of human activity – i.e., what, why, when, how, who, and where, as adopted by Baskin et al. (1998) and Sherif (2001) –, a coherent and integrated list of important dimensions of standardisation in the context of technological innovation is identified. They include *what* technology elements to standardise, *why* standards are needed, *when* to standardise, *how* to standardise, and *who* is leading or involved in standardisation. Although the issue of *where* standardisation is carried out have significant implications for standardisation landscapes, such as types of SDOs and their responsibilities, these vary significantly depending on national and regional contexts, including culture and history of institutional systems; it is thus suggested to be the best not to further categorise the issue of *where* and keep distinctions simply regarding the issue of *who*. These key dimensions and issues of standardisation are then incorporated in the framework proposed by Featherston et al. (2016), as shown in Figure 1. By carefully articulating and categorising all important dimensions of standardisation and capturing them in a holistic way, it is a more comprehensive and systematic framework than any previous models (e.g. Tassey 2000; Sherif 2001; Blind & Gauch 2009). Thus effectively representing the multi-dimensional nature of standardisation and how these dimensions interplay with each other, the framework can be a useful tool for not only analysing complex dynamics between standardisation and innovation, but also assisting strategic management of standardisation in support of innovation.

In order to demonstrate how this framework can support systematic and future-oriented analyses of standardisation and test the validity of its dimensions and their sub-categories, this paper presents a multi-dimensional analysis of standardisation in the context of PV. From the historical analysis of PV technology and relevant standardisation activities, the case study illustrates how various dimensions of standardisation incorporated in the framework are critical for understanding these complex dynamics between standardisation and innovation. It is also suggested from the case study that the proposed framework, by carefully capturing all these important dimensions, can effectively support strategic management of standardisation.

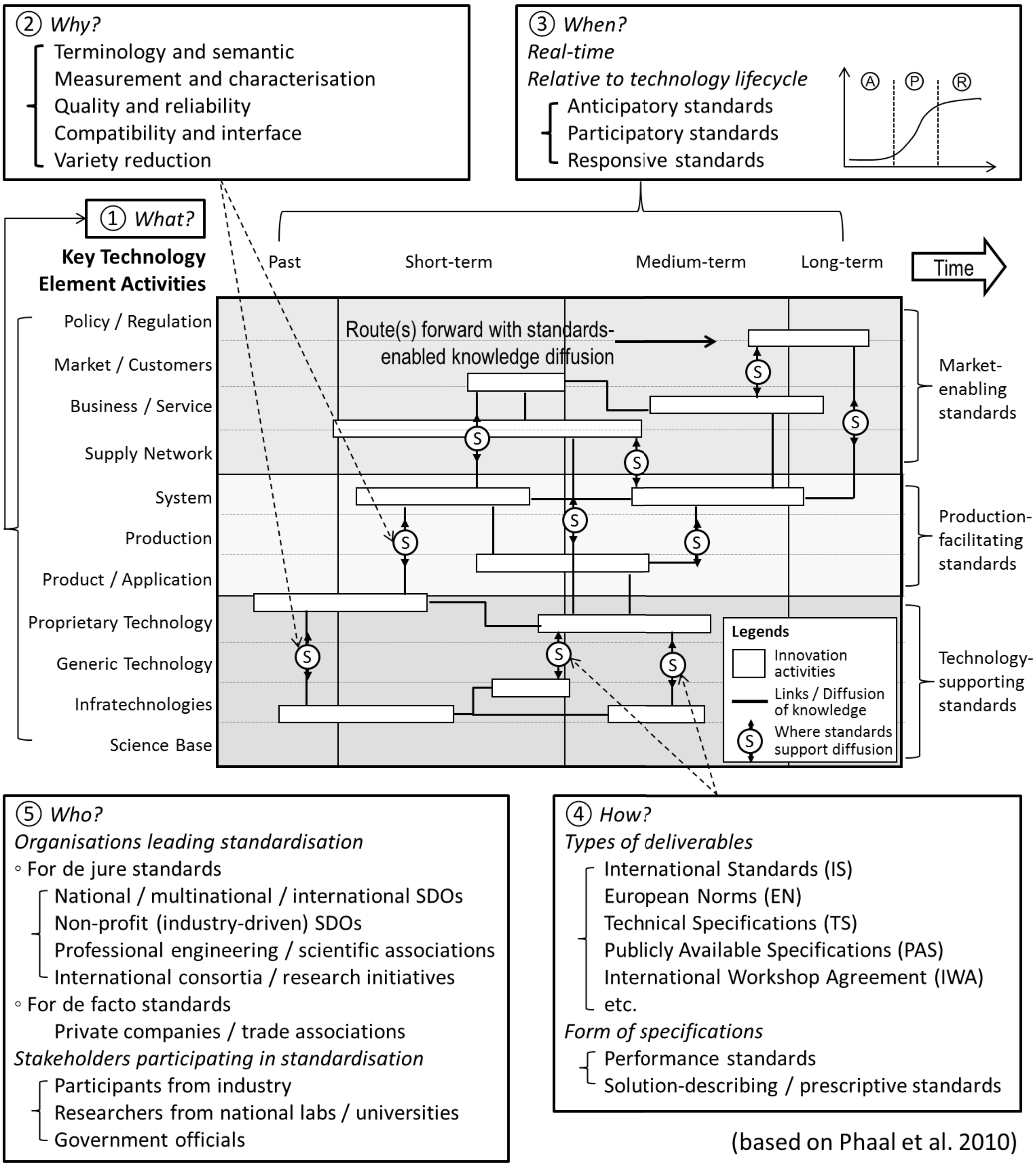

Figure 1. Framework for anticipating standardisation needs (Ho & O'Sullivan, 2015a)

3 Case Study of PV Technology

The case of PV technology is selected for this study, because of its various application areas, a variety of stakeholders involved, and a high level of systems complexity, all of which add intricacy and variety to its standardisation activities. Along with its long history of development, they provide rich information to explore various issues associated with complex dynamics between standardisation and innovation. In particular, the case study starts exploring standardisation in the innovation context of the US, as they dominated early PV standardisation. As the birthplace of PV technology, most of early innovation and development activities of PV took place in the US; PV standards developed by standards organisations based in the US thus had significant influences in international standardisation activities later. As international perspectives became increasingly important in standardisation with the development of international PV markets, the study later expands its scope to cover international context as well. Nevertheless, it is to be noted that early PV standardisation is greatly influenced by its national context and particular standardisation landscape of the US.

Given retrospective nature of the research, over 200 archival documents from various sources and perspectives – including standard publications, industry trade magazines, official reports published by governments and research laboratories, and journal articles – have been collected. Although many of these documents are available in the public domain, key documents and insights were obtained from the National Renewable Energy Laboratory (NREL) library, which houses extensive resources related to the history of PV technology that are not accessible elsewhere. These archival data, as well as the rich description offered in the PV industrial roadmap developed by Friligos (2010), were used to identify key events and activities during the historical development and standardisation of PV technology.

Semi-structured interviews were also carried out with experts who have been involved in various PV standardisation activities. Interviews not only complement documental resources by providing contextual backgrounds and details which might be difficult to access through document sources alone, but also generate insights into any relationships and linkages between key events. Archival documents, as well as preliminary studies exploring both quantitatively and qualitatively standardisation of PV technology (Ho & O'Sullivan, 2013, 2015b), have been drawn upon to inform and design interview questions. Interviewees are initially contacted from the list of members in technical committees for PV in major SDOs (ASTM E44, IEC TC82, IEEE SCC21, and PV Committee in SEMI), then approached using "snowball sampling" (Goodman, 1961). A total of 42 experts from a variety of organisations – including private companies, national laboratories, governments, and academia – across various areas of PV technology participated in interviews, ensuring the balanced representation of varied perspectives. It is to be noted that although most of them are from the US, key interviewees also have strong understandings of international perspectives of PV standardisation, based on their experiences in international committees.

Based on these data, detailed descriptions for complex dynamics of standardisation throughout the innovation journey of PV technology are presented in a narrative style. Structured in chronological order, the narrative is also captured and visualised using the roadmap-based framework, as shown in Figure 2; only major events and milestones are included here for practical reasons, especially ones relevant to standardisation activities explored in this case study (i.e. gaps in the roadmap doesn't mean that there are no activities, but activities are less significant or relevant to key standardisation). The figure includes the main framework depicting the overall narrative in the centre, as well as smaller frameworks focusing on certain periods of time for detailed illustrations of complex dynamics between innovation and standardisation in different phases of PV history. There are four broad phases of the PV innovation journey, divided according to the evolution of their main application areas: (i) transition from space applications to terrestrial applications (1976~1985), (ii) demonstration of grid-connected applications (1986~1995), (iii) introduction of large power systems (1996~2005), and (iv) emergence of smart grid (2006~2016). Key standardisation activities in each phase and their relationships with other innovation activities are explored and captured in the roadmap-based framework. Each standard and their key dimensions – *what, why, when, how,* and *who*, as identified in Figure 1 – highlighted in the case study are discussed in the following.

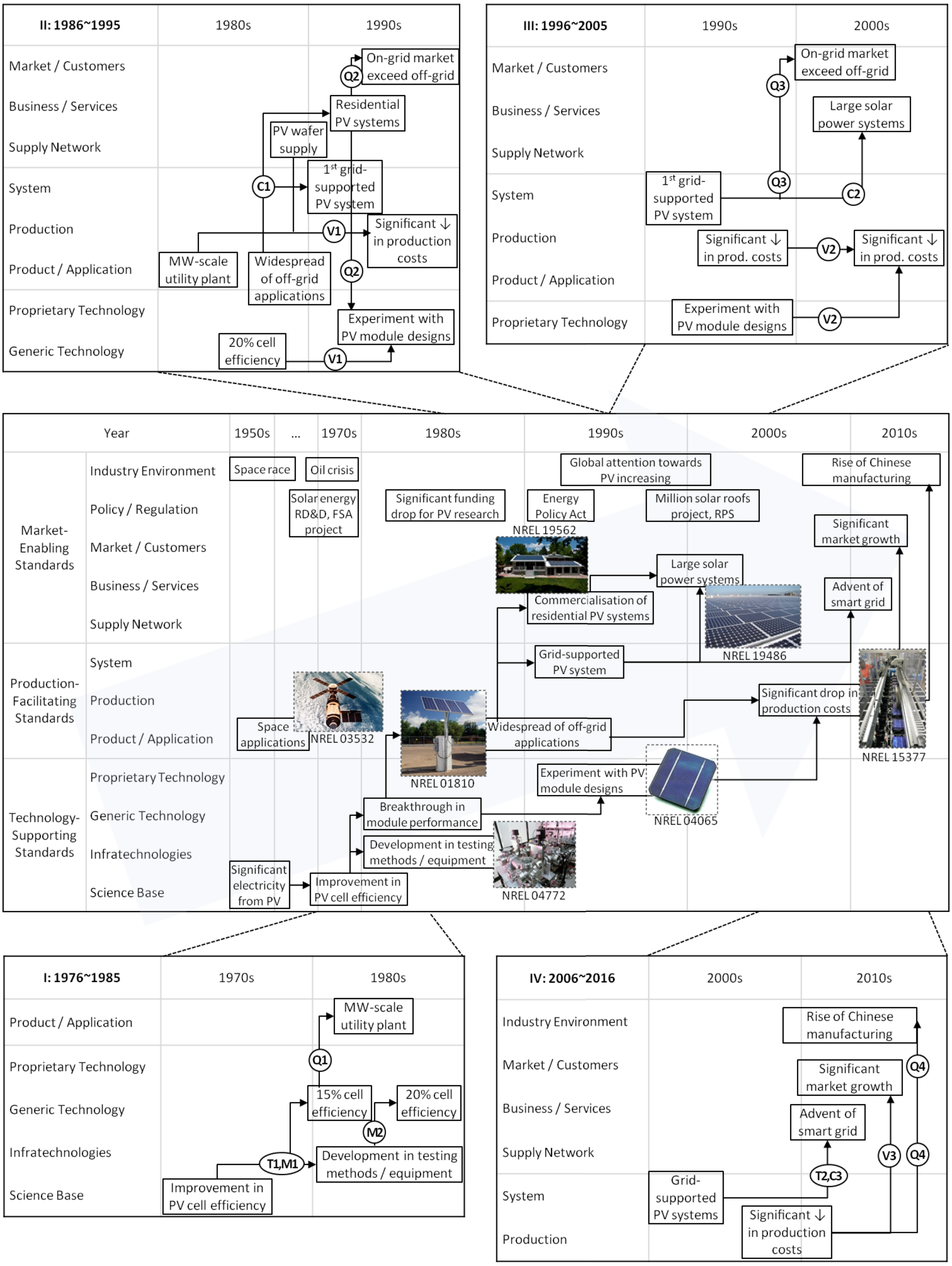

***Figure 2**. Systematic analyses of PV standardisation (all images from NREL 2016)*

3.1 Transition from a niche market of space applications to terrestrial applications for wider public (1976~1985)

Although electricity generated from the PV effect was first observed at Bell Laboratory in 1954, the technology remained in the niche market of space applications until the oil crisis in the 1970s, when PV gained great attentions as an alternative source of energy (Ksenya, 2011).

In order to address the problem of energy security, various government programs were proposed – including Energy Research and Development Administration (ERDA)'s National PV Program – supporting terrestrial applications of PV, and needs for appropriate standards were identified among the growing number of stakeholders involved in PV (Ross & Smokler, 1986). Consequently, two PV Measurement Workshops were organised by ERDA, resulting in the technical report (NASA TM 73702) which presented the first set of consensus-based standards (NASA, 1977). Although nearly 60 people from all sectors of the PV community participated in workshops, an interviewee noted that a large number of them was researchers from government laboratories – such as the National Aeronautics and Space Administration (NASA)'s Lewis Research Centre, Jet Propulsion Laboratory (JPL), and Sandia Laboratory – as they were more experienced in this emerging area with niche market of space applications.

T1: Terminology standard for PV technology

One of the most significant information incorporated in the report was the definition of key terminologies used in standards, including cells, modules, arrays, and efficiency (NASA, 1977). According to multiple interviewees, it made sure that the PV community agrees on what language they use, removing any potential confusion and facilitating communications when writing standards or interpreting them during research.

M1: Measurement / testing standards for PV cells and modules

The report also consisted of reference spectrum, standard test conditions, equipment, and procedures to be used in testing and measurement of cell performances (NASA, 1977). According to interviewees, having a standard method of measurement made it easier to not only compare performances of cells developed by different researchers, but also accurately assess the current status of technology development through rigorous traceability. An interviewee added that accurate assessment of research deliverables were particularly valuable for program managers and funding agencies to make decisions about funding, guiding research directions for technology improvement. Therefore, terminology and measurement standards included in the NASA report increased accuracy and efficiency of PV research, facilitating the development of both PV cells and technical infrastructure required to support technological development (including measurement methods and standard databases).

Q1: Qualification testing specifications for PV modules

Despite the significant improvement of generic technology in late 1970s, widely used terrestrial applications did not exist due to the lack of reliable and economically viable PV modules; many interviewees noted that customers (such as government and installation companies) were reluctant to use PV modules and panels, as early modules developed in 70s-80s frequently failed in the field due to low quality and reliability. Hence, the US government initiated the Flat-Plate Solar Array (FSA) Project at JPL, for an effective cooperative efforts between researchers and industry to stimulate the development of PV applications (Ross & Smokler, 1986). Requiring manufacturers to pass a set of prescribed tests to qualify for block procurements of PV modules, the project greatly increased the quality and safety of modules in the US market (Colatat, Vidican, & Lester, 2009). The last block procurement in 1981, Block V, was particularly remarkable, with its specifications document becoming the de facto standard for module quality (Osterwald & McMahon, 2009). Specifying both test procedures and performance criteria to pass the tests, it not only helped designers and manufacturers to develop products with higher quality, but also ensured customers to have confidence in module reliability, leading to the widespread off-grid terrestrial applications, according to numerous interviewees. For example, the first large, megawatt-scale PV utility plant was designed and built by Sacramento Municipal Utility District in 1983 (Yerkes, 2004).

M2: Refined measurement / testing standards for PV modules

Despite the increasing research activities in private sectors to meet the growing market needs for terrestrial PV applications, reference model and detailed procedures developed by NASA were not publicly available, making it difficult for the wider community to replicate reference spectrum in their research, noted an interviewee. As this hampered accurate performance of R&D and effective sharing of its results in a wider group of researchers, needs for more refined and publicly available standards were identified. As a result, technical committees dedicated to PV were established in SDOs, and works were divided according to their nature and expertise (Ross & Smokler, 1986). A number of interviewees recalled that a steering committee on solar energy was established for coordination and avoidance of duplicative efforts in standardisation among American Society for Testing and Materials (ASTM), Institute of Electrical and Electronics Engineers (IEEE), and Underwriters Laboratory (UL). An interviewee also highlighted that such efforts for coordination and division of labour led by government and public organisations were helpful in the beginning, as PV was an emerging industry where stakeholders had only fragmented understanding about the market, so industry was not strong enough to drive standardisation activities themselves.

Based on their expertise in test methods and specifications, ASTM E44 – which was mainly consisted of researchers at the time – developed a number of early measurement and testing standards for PV. ASTM E891 and ASTM E892 were published in 1982, presenting terrestrial direct normal solar spectral irradiance tables with more refined data and strong technical basis; this allowed anyone to generate the same reference spectrum across the world, making sure that their research results are verifiable and comparable, according to multiple interviewees. Interviewees also highlighted that ASTM E948 documented more detailed and clarified test conditions and procedures of measuring cell efficiency, so that performance can be measured accurately and consistently. In addition, a series of standard methods for calibration and characterisation of reference cells (ASTM E1039, ASTM E1125, ASTM E1144, and ASTM E1362) were published from 1985 to 1990, ensuring accuracy, stability, and reliability of efficiency results, noted another interviewee. Although these ASTM standards are solution-describing standards outlining procedures without setting criteria (unlike JPL specifications), they facilitate research activities of generic PV technology, by providing a level playing field where everyone can be measured against and guiding research directions for more effective technology improvement, according to an interviewee. Moreover, they supported the development of measurement techniques and testing equipment, which are important infratechnologies themselves. Because of such highly scientific and research-intensive characteristics, researchers from laboratories such as NREL actively participated in the development of these measurement and testing standards, by providing invaluable resources and experiences in characterising and testing PV cells and modules (McConnell, 2006). Such development of infratechnologies allowed enhanced traceability, leading to significant improvements in cell performances in 1980s, despite the decreased public research funding in favour of nuclear energy over PV during this period (Surek, 2003).

3.2 Demonstration of grid-connected applications (1986~1995)

The significant improvement of the quality of PV modules, along with the increased global attention towards PV due to the climate change in late 1980s, led to the growth of PV production and market. Yet, this was restricted to standalone, off-grid PV applications and systems, as utility companies were still concerned about safety and reliability of the new, unproven technology being connected to their grid, according to multiple interviewees.

C1: Compatibility / interface standard for residential PV systems

Compatibility standard which describes interface construction techniques and operating procedures for connecting PV systems with the utility was thus needed, in order to give confidence to utility companies, noted an interviewee. With their expertise in electrical and electronics systems, IEEE SCC21 developed IEEE 929 in 1988, documenting recommended practice for utility interface of residential and intermediate PV systems (Hester, 2000). Prior to its development, PV applications had been treated as other large-scale power generators, creating unnecessary barriers to its wide deployment; interviewees highlighted that this anticipatory standard was a prerequisite for PV systems to be integrated in larger grid systems, leading to the commercialisation of on-grid, residential solar power system in early 1990s.

V1: Variety-reduction standard for wafer size

An interviewee recalled that until 1980s, manufacturers often used wafers designed for computer chip manufacturing, which was available from semiconductor industry at the time. With the demonstration of the potential for grid-connected systems and increased government supports in late 1980s, the PV market of significant size had been established, leading to manufacturers' experiments with the wafer designed specifically for PV modules (Räuber, 2003). By early 1990s, 125mm wafer – used by Siemens and Sharp – was selected as the dominant design generating high outputs with low production costs, noted the interviewee. This responsive, de facto standard based on proprietary design allowed more economic production of PV modules and applications by generating economies of scale (for both wafer suppliers and manufacturers), leading to the significant drop in production costs, according to multiple interviewees. Another interviewee noted that the standard wafer size also increased R&D efficiency by facilitating communications between researchers and product designers.

Q2: International qualification standard for PV modules

Due to the growth of PV production and market across the world, demands for internationally accepted quality standards arose by manufacturers so that they could sell their products worldwide, noted multiple interviewees. International Electrotechnical Commission (IEC) thus developed IEC 61215 in 1993, defining specific sequences, conditions, and requirements for the design qualification of PV modules (Arndt & Puto, 2010). As a participatory standard with improvements incorporated as experience is accumulated, this quality standard presented more refined and advanced testing methods by adopting existing national or regional standards, such as those developed by JPL and the European Commission's Joint Research Centre (Treble, 1986). It could thus further increase consumer confidence and gain wider market acceptance, leading to the wide deployment of PV products and systems (Ossenbrink, Müllejans, Kenny, & Dunlop, 2012). In addition, a number of interviewees mentioned that it facilitated manufacturers' experiments with PV module designs, in attempts to identify reliable designs that could be produced with low costs and still pass the tests. It is to be noted that as the PV industry grew and more manufacturers entered into the market, companies also became more involved in the development of quality standards in order to gain competitive advantages through standardisation, according to multiple interviewees.

3.3 Introduction of large, complex power systems (1996~2005)

As the global awareness towards renewable energy increased (as shown by strong policies in Germany and enactment of Kyoto Protocol), the US government initiated a number of government programs – including Million Solar Roofs Project and Renewable Portfolio Standard – to increase the PV market in late 1990s (Colatat et al., 2009; Räuber, 2003). This led to the development of more reliable and cost effective PV systems, increasing the potential of PV as an alternative source of energy; however, the widespread of large PV applications and power systems could not be achieved without relevant standards in place.

Q3: Quality / reliability standard for Balance of Systems (BOS)

In addition to the quality of PV modules, the quality of other electronic components required – such as inverters, batteries, and power controllers, which are called BOS – also had to be ensured, to increase confidence of users – such as investors, installers, and project developers – of PV systems. UL 1741, the standard for inverters, converters, and controllers for use in independent power systems, was thus developed in 1999, based on IEEE 929 with addition of reliability and safety issues (Zgonena, 2011). It was also developed through a close coordination with the task group for National Electrical Code (NEC) Article 690 – i.e. an industry supported group addressing the installation safety of PV systems – in order to ensure more harmonised standardisation among different organisations (Bower, 1997). According to interviewees, this national standard was a major milestone in the US, as it resulted in the wide adoption of on-grid PV applications and systems, by increasing reliability and consumer confidence for larger PV systems. Data also supports that the off-grid dominated PV industry started to generate more electricity from on-grid systems since late 1990s (Mints, 2013). An interviewee added that a lot of its contents were later borrowed to develop IEC 62109, an international standard for the safety and reliability of BOS used in PV power systems.

C2: Compatibility / interface standard for PV power systems

For PV systems to be adopted in complex power systems, compatibility standards that establish successful linkages between distributed resources – such as PV and wind – with electric power systems were needed by utility companies and system developers (Basso, 2009). IEEE 1547 was thus developed by a group of researchers as well as utility companies in 2003, replacing previously developed IEEE 929 which covered intermediate PV systems only (Ji, 2009). A number of interviewees noted that this anticipatory standard not only allowed interconnections of quality distributed generators to larger grid systems, but also provided a common platform where advanced communications could be achieved among various products and systems. Some interviewees added that such issue of interoperability and communication is becoming more important with the widespread of PV, as utilities would need to communicate with them to better control the overall power system.

V2: Variety-reduction standard for module design

With the significant growth of PV market due to the introduction of larger power systems, de facto standards for module design appeared in early 2000s for more efficient productions. After numerous engineering studies and experiments by manufacturers to find out the optimal design, standardised designs for various dimensions – such as spaces between cells, number of cells in arrays, and thickness of panels – emerged in the market, noted an interviewee from the industry. He added that such responsive standards led to more economic production for manufacturers, by allowing them to use standardised equipment for certain module designs.

3.4 Emergence of smart grid (2006~2016)

In late 2000s, the PV industry experienced not only massive growth in terms of production and market, but also the advent of smart grid, which is an advanced power grid integrating many varieties of ICT with the existing power-delivery infrastructure. Such trends called for various standardisation activities led by diverse group of stakeholders involved.

V3: Variety-reduction standards for mass production

According to multiple interviewees, there were urgent needs for standards related to production processes, in order to not only improve communications between users and suppliers of PV manufacturing equipment, materials, and services, but also reduce variability in manufacturing processes to achieve economies of scale. Although existing standards developed by Semiconductor Equipment and Materials International (SEMI, a global trade association representing the semiconductor equipment and materials companies) were somewhat relevant, they were not entirely suitable for material processing required by PV manufacturers, noted another interviewee. Hence, a technical committee consisting of PV equipment and materials companies was established in SEMI, in order to modify existing standards and develop new guidelines for PV-related process equipment, materials, or components (SEMI, 2015). These standards developed by a consortium of supplier networks resulted in not only lower production costs, but also increased efficiency and consistency for process control, by improving traceability and optimising value-adding processes, according to multiple interviewees. An interviewee highlighted that such traceability is important for the development of a big industry, as most of technology improvement is done in regular production line rather than laboratory R&D. SEMI standards thus led to significant expansion of the global PV market through more efficient production since late 2000s (EPIA, 2011).

T2, C3: Terminology and compatibility / interface standards for smart grid

As the issue of interoperability between PV systems and the larger power grid became more significant, IEEE 2030 was developed in 2011, in order to further realise greater implementation of ICT for enhanced integration of various distributed energy generators with the grid, noted an interviewee. In addition to advanced communication provided by IEEE 1547, IEEE 2030 supports information exchanges where data and knowledge flows are implemented through interfaces (Basso, 2014). As it is the first systems level standard for the emerging area of smart grid, it also included definitions of key terminology used in the industry; since smart grid is an interdisciplinary area where people with different expertise and backgrounds need to work together, agreeing on common language from the beginning was important to facilitate communications among stakeholders across all tiers of the supply network, according to an interviewee. He also noted that as smart grid is becoming more complex and divergent, more of such interface standards involving a great number of stakeholders will be needed, in order to achieve the successful interconnection of PV technologies with various other technologies and systems.

Q4: Quality / reliability standard for PV production systems

As new PV manufacturers with mass production capacity have been recently emerging, there are increasing concerns among the PV community regarding quality management systems of mass manufacturing processes, according to multiple interviewees. Although qualification standards ensure the quality of PV module designs, they do not guarantee that high quality products are consistently manufactured in large factories. Therefore, IEC TS 62941 is recently published in 2016, providing guidelines for increased confidence in PV module design qualification and type approval (IEC, 2016). It specifies quality management systems required for manufacturers to increase the confidence that the production modules will continue to meet the quality implied by passing the module qualification tests, i.e. IEC 61215 for crystalline silicon, IEC 61646 for thin films, or IEC 62108 for concentrators (Wohlgemuth, 2014). Although there were identified needs for such information of quality controls to increase consumer confidence in mass manufacturing in China – which may allow further production growth and cost reductions –, there was a lack of consensus on technical details among members of the committee; it was thus published as TS, which may become IS when full consensus is achieved, noted an interviewee. Another interviewee highlighted that even though TS usually does not lag behind IS in terms of technical details and completeness, it allows greater flexibility until more data and information are gathered so that the industry gets familiar to make better decisions.

4 Discussion

4.1 Demonstration and minor revision of the framework

The case study illustrates how the framework in Figure 1 can be used for more systematic and comprehensive analyses of complex dynamics between innovation and standardisation of PV technology. As these dynamics are context-dependent, the holistic and integrative approach of a roadmap-based framework is useful to have a broad picture of various perspectives on how standardisation shapes the process of technological development and diffusion, facilitating overall innovation systems. It does so by not only capturing all important aspects of standardisation in the context of technological innovation – *what*, *why*, *when*, *how*, and *who* –, but also providing more careful articulation and characterisation of each of these dimensions. Although all dimensions and their sub-categories identified by Ho & O'Sullivan (2015a) are proved to be critical for such multi-dimensional approach to standardisation, the case study suggests that the framework can be further improved by incorporating the following issues.

'What' innovation elements are relevant to standardisation

Multiple interviewees noted that although general activities of the industry outside the innovation system in question do not directly influence standardisation, they still provide important contexts by serving motivations or backgrounds of other innovation activities. For example, space race and increased attention to energy security were important motivations for PV research; international landscape such as policies in Germany and growth of Chinese manufacturing also had significant impacts on PV production and market in the US. Hence, it is appropriate to include 'industry environment' as a separate category of '*what*'.

In addition to federal government policies and regulations, codes adopted by local state governments are found to have significant influences on standardisation activities. A number of interviewees noted that changes in NEC Article 690 often triggered revision of existing standards (e.g. UL 1741 to include ground fault protection) or even development of new ones (e.g. UL 1699B outlining investigation for PV DC arc-fault circuit protection). Hence, it is appropriate in 'policy & regulation' category to also consider such regionally enforced regulations and codes which have significant impacts on standardisation activities.

'Who' is leading and involved in standardisation

As standardisation activities are mainly driven by the industry rather than government in the US, non-profit SDOs (e.g. ASTM) and professional engineering or scientific associations (e.g. IEEE) also develop national standards. Hence, it may be more appropriate to distinguish between these Sectoral or Specialised Standards Organisations (SSOs, professional or specialist organisations comprised of organisations or individuals in particular business sectors or professional disciplines) and Formal Standards Organisations (FSOs, SDOs operating through national representation formally recognised by government authority), rather than categorising them by national, multinational, and international SDOs (Hatto, 2013).

In addition to companies from the PV industry (including manufacturers and suppliers), users and consumers of PV products and systems (such as investors, installers, project developers, and government) are also greatly concerned in standardisation to ensure high quality, reliability, and safety of products. Multiple interviewees noted that it is important to reflect interests and perspectives of such users, as they provide useful perspectives from installation and end-use of products and systems. As representatives of small companies who don't have enough resources to devote, trade associations are also important participants of standardisation activities, according to an interviewee. Moreover, a number of interviewees highlighted the significant role of individual consultants who, based on their long experiences in the PV industry as an employee, now work independently as a specialist in PV standardisation. By participating in multiple SDOs, they may provide a broader perspective on standardisation activities of the overall industry, noted the interviewees.

4.2 Further insights into dynamics between standardisation and innovation

The case study also illustrates a number of interesting trends and patterns of how dimensions of standardisation evolve and interact with each other throughout the PV innovation, reflecting changes in innovation systems. Such trends are due to the evolving emphasis on types of technologies and innovation activities across different stages of innovation, requiring different standardisations involving various stakeholders; these are discussed as below.

'What' innovation elements are relevant to standardisation

There were more technology-supporting standards developed in early stages of innovation where basic scientific research dominated; as PV systems developed and market expanded, first production-facilitating standards, then market-enabling standards were mainly developed. Nevertheless, interviewees noted that as new technologies are continuously being introduced, new technology-supporting standards appear mostly in related technological areas or different materials, other than generic PV technology that is basis of current PV products and systems.

'Why' standards are needed

Although standards playing the same roles are needed at different phases of PV innovation associated with different categories of technology, there is a general trend that standards with particular roles and functions dominated at certain stages of the innovation journey: measurement / testing standards in early PV technology development, quality / reliability standards with the introduction and demonstration of applications, and compatibility / interface standards with the widespread of larger systems. According to a number of interviewees, similar trends could be observed in not only other countries that were the main players of PV history, but also different types of PV technology, such as concentrators.

'When' to be standardised

While many standards were – either perfectly or partially – participatory standards, evolving and being refined with technology improvements, some standards with particular roles tended to be of different types. Many variety-reduction standards, especially regarding certain dimensions or characteristics of products, were responsive standards, as they were defined after their performance or success had been demonstrated. On the other hand, compatibility / interface standards were anticipatory standards, since they had to be defined in advance to ensure that different products and systems can be connected and interoperable to each other.

'How' to standardise

It is interesting to note that all quality / reliability standards illustrated in the case study were both performance-based and solution-describing standards, specifying both desired outcomes or performance criteria and how to perform test procedures to assess these performances.

'Who' is leading and involved in standardisation

In early days of PV, standards were mostly developed by researchers from national laboratories or academia, with resources supported by government to perform research in the emerging technology with high risks. As potentials of PV applications were demonstrated, manufacturers and other companies – including suppliers and investors – also participated;

system-related stakeholders – such as utilities, system integrators, and installers – joined, as on-grid systems market expanded. There are now a variety of stakeholders involved in PV standardisation, each coming from different organisations and disciplines, leading to increased complexity in negotiation and consensus building, according to many interviewees.

5 Conclusion

The historical case study of PV technology is carried out, in order to verify the framework developed by Ho & O'Sullivan (2015a) for systematic analyses of standardisation (shown in Figure 1). Capturing five key dimensions of standardisation – '*what'* elements are relevant to standardisation, '*why'* standards are needed, '*when'* to be standardised, '*how'* to standardise, and '*who'* is leading and involved in standardisation – in a coherent and integrated way, this roadmap-based framework is proved to be more advanced than existing conceptual models in two main ways. It provides a more holistic and comprehensive perspective of overall dynamics between standardisation and innovation; it also provides detailed characterisation of important dimensions of standardisation in the context of innovation. Through the multi-dimensional analysis of PV history, the case study effectively shows how standardisation evolves across different stages of innovation journey, reflecting changes in technological and industrial systems. As there are significant shifts on types of technologies and innovation activities across different phases of innovation, different types of standards in terms of their roles and associated innovation elements are required by different stakeholders involved. Changes of emphases in dimensions of standardisation and their categories are thus inevitable, reflecting evolutions of innovation systems as technology develops and industry matures.

Such analyses not only enhance previous theoretical works by increasing our understandings of standardisation dynamics grounded in case studies, but also provide practical insights that standardisation may be useful indicators of changes in technological 'paradigms', as claimed by Metcalfe & Miles (1994). As there appear to be close relations between them, multi-dimensional analyses of standardisation may provide greater insights into dynamics and transitions of technological innovation systems, helping the community make more informed decisions when developing innovation strategies. For example, key characteristics and patterns of standardisation activities – especially when considered in an integrative way – may be used as indicators or demonstrators of particular phases of the technology emergence and development, helping identify current status of the innovation journey. Such information can inform policymakers and other business managers to not only make appropriate reviews or strategic decisions in a timely manner, but also guide how various actors should coordinate with each other at each stage, supporting innovation more effectively. It would be interesting to further examine such issues regarding potential roles of standardisation as defining or indicating features of technological paradigms and innovation systems.

Another managerial implication is that the proposed framework may also be used as a practical tool for helping standards organisations and policymakers anticipate future standards needs and develop relevant standardisation strategies. Such future-oriented analyses are supported not only by more comprehensive understandings of complex dynamics between standardisation and innovation, but also due to the basic function of roadmapping as a foresight tool, where various stakeholders are brought together to make strategic decisions to achieve a common vision. Demonstrating the importance of five key dimensions and their sub-categories for understanding complex dynamics between standardisation and innovation, the case study suggests that all these dimensions need to be appropriately considered for effective standardisation foresight. It also provides additional insights to be incorporated, leading to minor revisions of the framework with more careful articulation and characterisation of each dimension. These include addition of industry environment and refinement of policy & regulation in '*what*', addition of users and consultants in '*who*' is involved in standardisation, and refinement of '*who*' is leading standardisation; as these are relatively marginal changes, the improved framework is not reproduced here. Future research may involve more case studies to test the framework in a variety of technological domains, exploring dynamics between standardisation and innovation in greater details. They may lead to further articulation and detailed characterisation of various issues regarding standardisation in the context of innovation, such as processes of variation and selection, as identified in existing literature adopting an evolutionary perspective (e.g. Metcalfe & Miles 1994).

Last but not least, there is evidence that demands for such use of the proposed framework for standardisation foresight will significantly increase in the future. By providing an overall view of complex dynamics of standardisation from various perspectives, the roadmap-based framework is particularly useful for gathering the growing number of stakeholders, who have different interests and make different contributions, but have a common goal of supporting the overall innovation system through standardisation. As modern technologies are becoming more complex, interdisciplinary, and fast-evolving at the same time, such efforts for collaboration among experts from different backgrounds and disciplines are becoming more significant, in order to meet increasing demands for timely and efficient development of highly complex standards. In addition, as more standards developed by different SDOs are being interrelated with each other (e.g. IEEE 929 and UL 1741, IEC 61215 and IEC TS 62941 as shown in the case study), the roadmap-based framework would make it easier to observe such interactions and linkages, helping achieve coherence and harmonisation of various standardisation activities. Since the framework is flexible and scalable – as demonstrated from the case study where particular perspectives in certain periods of time are zoomed in for exploring details of dynamics between standardisation and innovation – it is also possible to collate individual roadmaps developed by different SDOs and integrate them for a broader standardisation plan of the overall industry.

6 Reference

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The Role of Regulations, Standards and Intellectual Property Rights in Commercialization of Business Innovation: A Support or a Burden?

Jan Hunady, Marta Orviska

Matej Bel University, Banska Bystrica, Slovakia

jan.hunady| marta.orviska @umb.sk

Abstract: *The study examines the problems faced by businesses when innovating and then commercializing their innovation. It is particularly focused on the role of standards, regulations and intellectual property rights in the commercialization of innovative products and services. The analysis has been conducted based on data from the Flash Eurobarometer 394 survey. We analyse the factors affecting the likelihood of a company having problems with the cost or complexity of standards, lack of standards or problems related to intellectual property rights. The actual effects of each potential problem on the commercialization of innovative products are examined using logit and ordered logit regressions. On the one hand, costly or complex standards seem to be a deterrent to the commercialisation of innovation. This is especially evident in Portugal, Italy, Poland and France. On the other hand, a lack of standards may harm the commercial success of innovation measured by the share of turnover due to innovation. Financial or non-financial government or administrative support may be an effective way to promote the commercialisation of innovation in the case of intellectual property rights. This problem is particularly significant in the fields of information and communication, manufacturing, real estate, as well as in science and technology companies.*

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Keywords: *Standards; intellectual property rights; innovation; commercialization.*

1 Introduction

Innovations represent one of the key factors leading to increased productivity and competitiveness in the economy. There is substantial evidence that the EU as a whole is not performing well in terms of innovation and in particular is lagging behind countries such as the USA and South Korea. Another very important problem which is even more evident in the EU is concerned with the commercialization of business innovation. Despite the fact that there are a significant number of companies that try to innovate their products or services, there is still a relatively high proportion of those who fail to effectively commercialise them. In this case innovation could mean only unnecessary costs with no immediate benefits to the firm.

It is obvious that the motivation of private enterprises to innovate is rather low in such circumstances. There are many potential barriers that could prevent firms from commercialising their innovations. The role of standards and intellectual property rights in the commercialization of innovation is rather ambiguous. They could be seen as a significant stumbling block to, but also as some assistance with, the commercialisation of innovative products. Blind (2013) has reviewed the evidence on the linkages between standardisation and innovation, in the process looking at the role factors such as of public procurement and intellectual property rights. In general he found only very limited empirical evidence of an impact on innovation, particularly a causal impact. This is a gap in the literature this paper seeks to fill. In particular we seek to identify whether standardisation facilitates innovation or places a barrier in its way. There is also an interaction between intellectual property rights and standards on several dimensions. For examples technical standards often involve the absorption of intellectual property rights, whilst their incorporation within a standard can give added value to the patent.

In this paper we will examine such effects using a data base on firms which accesses information on individual firms' innovation. We also identify the key factors affecting the probability that a firm has problems relating to standards, regulations or intellectual property rights respectively. In the next section we will review the literature both on innovation and standards. In section 3 we will discuss the data we use in the analysis. It will be based on the Flash Eurobarometer 394 survey carried out in January and February 2014 which includes questions about innovation activities and the commercialization of innovation. In section 4 we analyses this data using logit and ordered logit regression, and then finally we conclude the paper.

2 Literature Review

There can be found several definitions of innovation and the innovation process in the literature. Schumpeter's analysis included: (i) production of a new product or an existing product in a new quality, (ii) the introduction of a new manufacturing process in production, (iii) the use of a new hither-to unknown source of raw materials, (iv) gaining new markets, and (v) changes in the management and organization of production (Jac, 2005). These correspond quite closely to the different measures of innovation we will be using, although we further distinguish between new goods and new services.

Mulgan and Albury (2003) define innovation as the successful implementation of a new or significantly improved product or service, process, a new marketing method, or a new organizational method that will bring substantial improvement to the economy, efficiency and quality of outputs and results. According to Greenhalgh and Rogers (2010) innovation can be defined as the application of new ideas to the product, processes, or other aspects of the activities of a firm that increase "value". Once more all of these have reasonably close equivalents with the types of innovation we will analyse.

Patents are often used as a proxy for inventions as for example by Artz et al. (2010). Inventions are seen as the first step towards innovation. Zachariadis (2003) argues that R&D expenditure is mostly reflected in the number of patents and patents have a positive effect on the development of technologies, which raises economic growth. Furthermore, similar effect of patents on growth is also shown by Hudson and Minea (2013). Moreover, Lin et al. (2013) used sales from patents as an alternative measurement of the innovation output of Taiwanese manufacturing firms.

As reported by Anselin et al. (1997), the accumulation of knowledge and its spillover into productive capacity through technological change is a central them in the new theory of endogenous growth. This is in line with the Triple Hellix model, where the relationships between universities, industry and government are the key factor for innovation and further technological development (Etzkowitz and Leydesdorff, 2000).

Innovation activities in enterprises depend on several determinants. Zemplinerova and Hromadkova (2012) mention the firm's age, size and strategic features such as being a member of a group, orientation on foreign markets. There are also certain barriers to innovation such as financing, market competition and the economic situation of the country. Again we will be capturing many of these variables in our analysis. Vieites and Calvo (2011) identified as determinants of business innovation, human resources, and other organizational factors related to research and development (centralization, specialization etc.), financial resources and innovation support, technology resources, information and knowledge management, and research and development activities. In general, we can divide potential determinants of innovation in the enterprise into internal and external. Internal factors include for example, company size, company age and export orientation. External factors might include, e.g., conditions in a particular country, the intensity of competition in the domestic market, cooperation with external institutions and financial support of innovation from the state or other institutions.

Beginning with Schumpeter (1942), many have emphasized the positive relationship between size and innovation. But there is by no means complete agreement on this and Koudelkova (2014) found no significant relationship between the company size and successful innovation in the case of small and medium enterprise in Czech Republic. However, many studies, including Cohen and Klepper (1996), do show a positive relationship between R&D intensity and the size of a company. Still other studies (Acs and Audretsch, 1988) have found a negative or (Aghion et al. 2005, Zemplinerova 2010) an inverted-U shaped relationship between size and the R&D intensity. One of the potentially most important external factors is the degree of competition. Boone and Van Dijk (1998) argue that, if R&D is effective enough (if innovation is not too costly), a rise in competition increases total R&D expenditures. Lesakova (2014) argued that small and medium enterprises (SMEs) are forced to innovate, because of permanent competitive pressures. Aghion et al. (2005) in their empirical results show an inverted-U pattern between competition and innovation. Their analysis was based on firms listed on the London Stock Exchange during the 1973-1994 period. Obviously, innovation would not be possible without sufficient financial resources to facilitate the transformation of new ideas into successful innovation. Based on the survey conducted on 857 firms Lesakova (2014) concluded that a lack of financial resources is the main barrier to innovation for SMEs in Slovakia. Klemet (2014) also confirm that the biggest obstacle for increasing the intensity of innovation in Slovakia seems to be the lack of own capital. However, the total amount of financial support is not the only problem.

Standards may perform several roles including raising the efficiency of the organisation. This is potentially the case with standards such as ISO 9000 which is related to management practices. They are a signal of organisational quality and whether or not they actually do improve quality, ISO 9000 certification is a signal of such in a world of asymmetric information (Hudson and Orviska, 2013). In line with ISO's initial remit, such standards may serve to reduce information costs and, thereby, increase trade (Swann et al. 1996). Although often viewed as voluntary, such international quality standards are sometimes required by regulation, particularly when trading in the EU. A second type of standard is some form of minimal quality that is common with respective, for example, to food. But it is far from restricted to food. The Waste, Electrical and Electronic Equipment (WEEE) regulations make producers responsible for their products when they become waste. Related to WEEE is the RoHS Directive connected with Restrictions of Hazardous Substances in Electrical and Electronic Equipment which puts limits on the maximum permitted level of lead, mercury, cadmium, etc. in a product (Orviska et al., 2014). Standards related to food, benefit the quality producer in tending to drive low quality producers out of the market and through signalling quality, give consumers confidence that they can safely purchase goods. Some electrical standards perform the same rule, but the WEEE regulations have not been imposed to facilitate completion but rather to achieve another objective of society – reduce environmental damage and pollution. The signalling argument applies to firms higher up the supply chain as well as consumers. This is particularly the case if standard certification reduces the need for purchasing firms to undertake their own quality control checks on supplier firms (Tirole 1988)[1]. Hence, Anderson et al. (1999) suggest, and provide empirical support for, the hypothesis that firms supplying to other firms are particularly likely to face demands for ISO certification. Governments too, often require some measure of quality certification such as ISO 9000.

Vollebergh and van der Werf (2014) found that environmental standards contribute to the effective development of innovations which reduce environmental impacts. They also argue that the same is true for many other types of standards, which could facilitate innovation and the diffusion of technologies.

3 Data And Methodology

The data from Flash Eurobarometer 394 survey have been used in the empirical analysis. This survey has been carried out in January and February 2014 and includes firms' answers on questions about innovation activities, the commercialization of innovation as well as the public support of innovation. The survey has been conducted using ad hoc telephone interviews at the request of the European Commission. All questions and answers of this survey have been summarized and graphically illustrated in European Union (2014). Together 12,108 firms from Switzerland, USA and 28 EU member states have responded to the questions. However, we used only the data for the EU countries in our regressions. All the variables used in this study are defined in an appendix.

Based on the data, Table 1 provides information on the characteristics of firms who innovate. It tells us that small firms are less likely to innovate with respect to all types of innovation.

Table 1: Different types of innovation across different types of firms in:

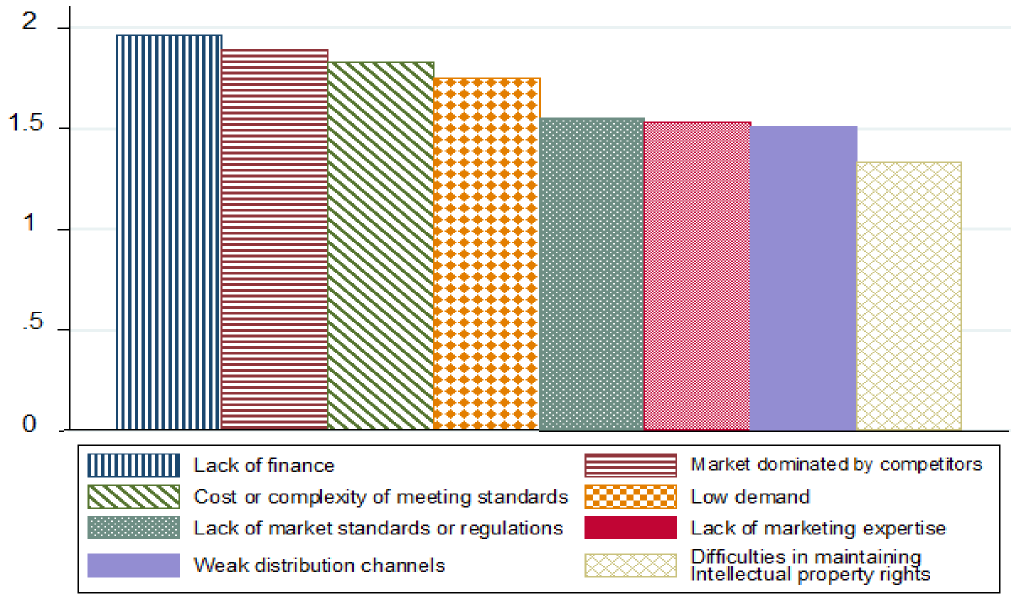
	Goods	Services	Processes	Marketing	Organization	Average
All	0.38	0.39	0.35	0.32	0.33	0.354
Small	0.32	0.34	*0.24*	*0.26*	*0.25*	0.282
Export focus	**0.50**	0.37	**0.45**	0.34	0.38	0.408
Young	*0.27*	**0.43**	*0.26*	0.30	0.33	0.318
Sell to government	**0.40**	**0.45**	0.37	0.35	0.38	0.390

Notes: 5 highest correlations are emboldened and the 5 lowest italicised. Export focus is defined as those firms with an export share in excess of 10%, small are firms with 1-9 employees, young are firms started since January 2013, Source: derived from Flash Eurobarometer 394 survey.

However, this does not mean that innovation per worker or assets employed are less than in larger firms. In addition the innovative small firm may be tomorrow's large firm, as for example with Apple. Having an export focus tends to be associated with particularly large levels of innovation, apart from service innovation. In particular innovation in goods and processes is substantially stimulated. Innovation, particularly in services and organisation, is also stimulated by having the government as a customer. Finally, young firms tend not to innovate. Again this may be misleading, for almost by definition young firms innovated at birth. Hence they may be newer and up to date in all their activities. Despite this, they do have a high propensity to innovate in services.

[1] For example, when three US car manufacturers adopted ISO 9000 procedures it replaced three separate programs that required suppliers to submit different sets of documentation and allow periodic audits by the car firms. ISO 9000 registration then became the only supplier requirement.

Secondly, we turn to the constraints firms experience in commercialising their products or services. We analyse problems regarding commercialisation as reported by firms. The answers on the question about potential problems have been coded 1-3 where 3 means it a major problem, 2 a minor problem a 1 means it is not a problem at all. The average values for each problem are shown in the Figure 1.

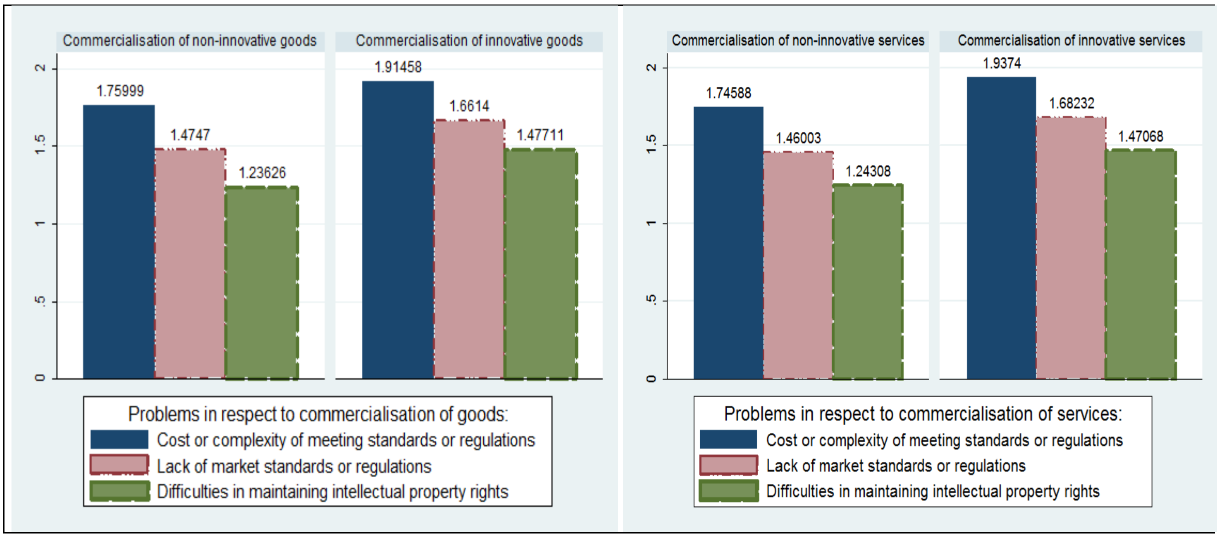


Source: Authors calculations based on data obtained from Flash Eurobarometer 394 survey.

Figure 1 Problem in the commercialisation of innovative and non-innovative products

As can be seen, the most common constraint to the commercialisation of all types of products was lack of finance. More than 33 % of firms in the sample declared this as a major problem for them. Competition seems to be the second most important factor. The cost or complexity of meeting standards or regulations is at third place. This problem is of course of particular importance for our analysis. More than 24% of firms in the sample mentioned that this is a major problem for them with respect to the commercialisation of their products and more than 31% see this factor as a minor problem. On this basis it would appear that the major problems firms face are a lack of finance, competition and complex or costly standards or regulation. On the other hand, a lack of standards appears to be a less intensive problem for most of the firms. However, the lack of standards is still either a major or minor problem for approximately 36% of firms.

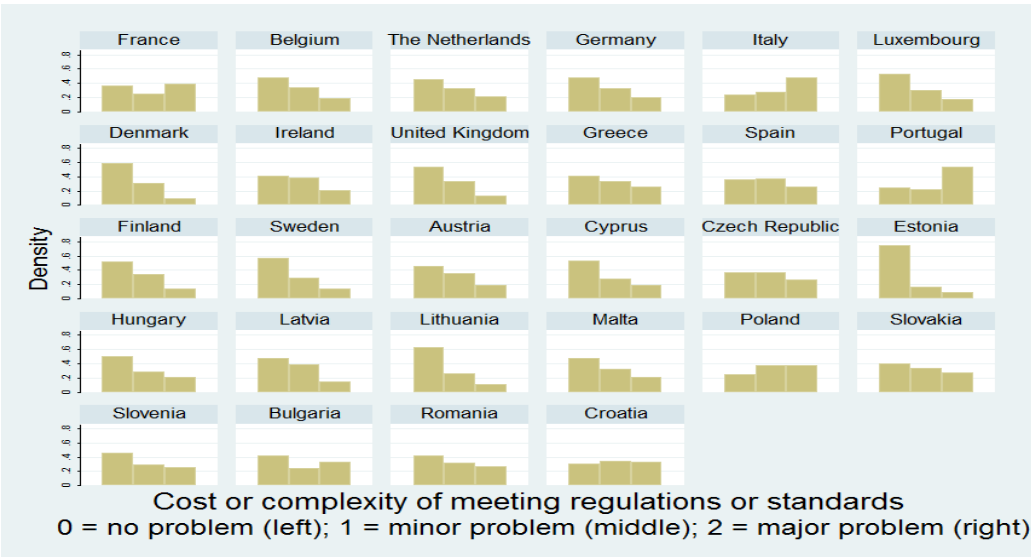
When we distinguish between the commercialisation of innovative and non-innovative goods and services, as could be expected, problems with standards and intellectual property rights are more substantial for innovative products. Thus, all three problems related to standards become more crucial issues when firms try to commercialise their innovative products. This is especially true for intellectual property rights, where the difference between innovative and non-innovative goods or services is the highest. The graphical illustration of this can be seen in Figures 2 and 3.



Source: Authors calculations based on data obtained from Flash Eurobarometer 394 survey.

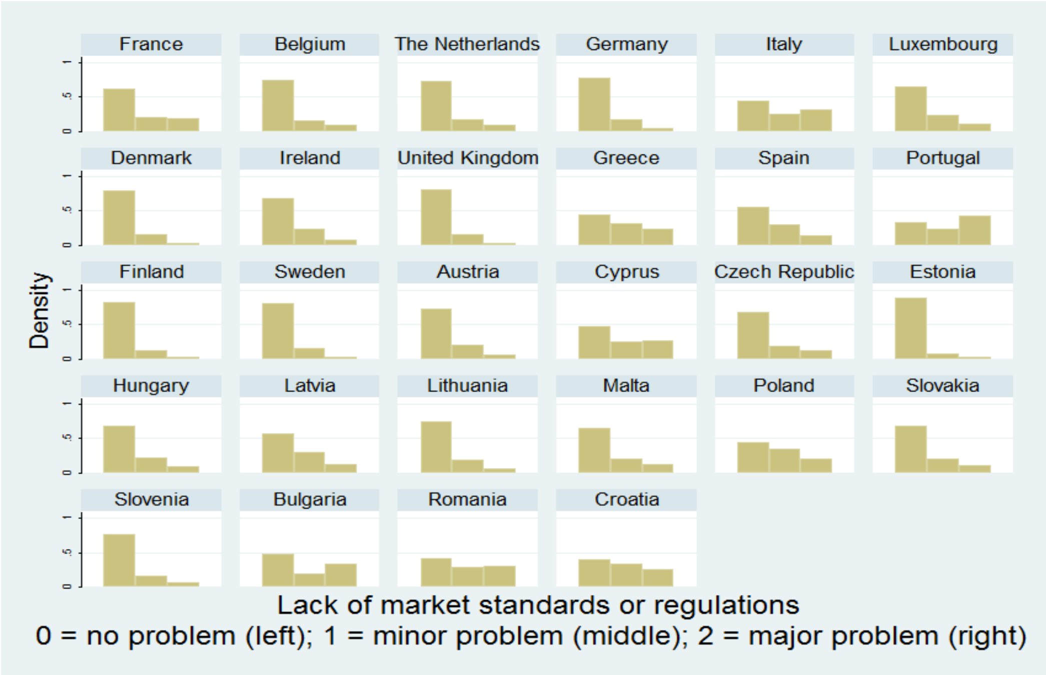
Figure 2 and Figure 3 Selected problems with commercialisation of innovative and non-innovative goods (left) and services (right)

Turning to differences between countries, the cost or complexity of meeting standards and regulations appears to be the most significant issue in Portugal, Italy and Poland as can be seen in Figure 4. Interestingly, the lack of market standards or regulations is perceived as the most significant problem again in Portugal, followed by Romania, Bulgaria, Cyprus and Italy as shown in Figure 5.



Source: Authors calculations based on data obtained from Flash Eurobarometer 394 survey.

Figure 4 Problems from cost or complexity of meeting standards or regulations in the EU countries



Source: Authors calculations based on data obtained from Flash Eurobarometer 394 survey.

Figure 5 Problems from a lack of market standards or regulations in the EU countries

In the next section we will examine the potential consequences of these constraints on the successful commercialisation of business innovation using logit regressions. Furthermore, we will also identify the key determinants of these problems and evaluate the effect of external support for meeting the standards or applying for intellectual property rights.

It seems probable that the problems with respect to the commercialisation of products could be different across sectors or countries. In line with this assumption we decided to examine the potential determinants of the three commercialisation problems related to standards and intellectual property rights. We seek to identify the specification of companies where this kind of problem appears to be especially significant by using ordered logit regressions. In doing this we seek to fill the gap identified by Blind (2013) as discussed earlier. In particular we seek to identify whether standardisation facilitates or places a barrier in the way of innovation and how its impact varies with the characteristics of both firms and countries.

4 Results

In the first part of the analysis, the cost or complexity of standards and regulations has been used as the dependent variable. The results, which are shown in Table 2, suggest that cost or complexity of standards is a less severe problem for wholesale, information and communication and real estate firms. The same is true for professionals and companies involved in scientific or technical activities. There seems to be an inverse U-shaped relationship between export focus and the problems with standards cost or complexity. The coefficients by country fixed-effect are in line with our previous findings. That is, the most intensive problems with the cost of standards are in Portugal, Italy and Poland.

Table 2: The results of ordered logit regression models – cost and complexity of standards

Cost or complexity of standards and regulations (0 = not a problem, 1 = a minor problem, 2 = a major problem)					
	Coef.	Country fixed effects	Coef.	Country fixed effects	Coef.
Size	-0.00001 (-0.25)	Belgium	-0.583*** (-4.13)	Hungary	-0.590*** (-4.00)
Year started	-0.089* (-1.66)	Denmark	-1.100*** (-7.76)	Latvia	-0.659*** (-4.81)
Market competition	0.076*** (3.13)	Greece	-0.192 (-1.33)	Lithuania	-1.201*** (-8.00)
Export share	0.011*** (3.67)	Spain	-0.119 (-0.89)	Malta	-0.534*** (-3.04)
Export share^2	-1.10e^{-6} *** (-3.42)	Finland	-0.782*** (-5.61)	Poland	0.420*** (3.14)
Sell to consumers	0.191*** (4.36)	France	0.233 (1.61)	Romania	-0.181 (-1.24)
Sell to companies	0.224*** (4.32)	Ireland	-0.289 (-2.08)	Slovakia	-0.087 (-0.60)
Sell to public sector	0.127*** (3.05)	Italy	0.756*** (5.29)	Slovenia	-0.441*** (-3.00)
C – Manufacturing	-0.077 (-0.75)	Luxemburg	-0.741*** (-4.25)	Cut 1	-0.243 [0.178]
D - Electricity Gas and	-0.072 (-0.35)	Netherlands	-0.451*** (-3.15)	Cut 2	1.220 [0.178]
E - Water and waste	0.045 (0.27)	Austria	-0.498 (-3.51)		
F – Construction	-0.080 (-0.78)	Portugal	0.788*** (5.17)		
G – Wholesale	-0.199** (-1.99)	Sweden	-0.902 (-6.18)		
H – Transport	0.161 (1.32)	Denmark	-0.558*** (-4.05)		
I - Accommodation and food	0.105 (0.82)	Great Britain	-0.831*** (-6.12)		
J - Information and communication	-0.562*** (-4.23)	Bulgaria	-0.042 (-0.27)		
L - Real estate	-0.331** (-2.02)	Cyprus	-0.557** (-2.26)		
M - Professional, scientific and technical activities	-0.308*** (-2.77)	Czech rep.	-0.178 (-1.28)		
Arts, entertainment and recreation	-0.039 (-0.21)	Estonia	-1.740*** (-10.79)		
Number of observations	10386	Wald X^2	870.19	Log pseudolikelihood	-10619.9

Notes: based on data obtained from Flash Eurobarometer 394 survey. Regressions done by ordered logit with standard errors corrected for heteroscedasticity. Variables are all defined in an appendix. (.) denotes z statistics, $^{*}/^{**}/^{***}$ mean significance at the 10%/5%/1% levels of significance.

Table 3: The results of ordered logit regression models – lack of market standards

Lack of standards or regulations (0 = not a problem, 1 = a minor problem, 2 = a major problem)					
	Coef.	Country fixed effects	Coef.	Country fixed effects	Coef.
Size	-0.00008 (1.29)	Belgium	-1.396*** (-8.74)	Latvia	-0.687*** (-4.83)
Year started	-0.038 (-0.65)	Denmark	-1.671*** (-10.32)	Lithuania	-1.436*** (-9.24)
Market competition	-0.005 (0.48)	Greece	-0.0287 (-0.20)	Malta	-0.936*** (-4.73)
Export share	0.006** (2.12)	Spain	-0.572*** (-4.26)	Poland	-0.112 (-0.84)
Export share^2	-8.85e^{-7} ** (-2.24)	Finland	-1.908*** (-11.35)	Romania	0.178 (1.23)
Sell to consumers	0.146*** (2.96)	France	-0.691*** (-4.76)	Slovakia	-1.023 (-6.49)
Sell to companies	0.051 (0.90)	Ireland	-1.073*** (-7.16)	Slovenia	-1.433*** (-9.07)
Sell to public sector	0.248*** (5.26)	Italy	0.088 (0.62)	Cut 1	-0.306 [0.192]
C - Manufacturing	-0.224* (-1.95)	Luxemburg	-0.995*** (-5.36)	Cut 2	1.033 [0.193]
D - Electricity Gas and	-0.148 (-0.64)	Netherlands	-1.246*** (-7.93)		
E - Water and waste	-0.152 (-0.80)	Austria	-1.308*** (-8.43)		
F - Construction	-0.241 (-0.55)	Portugal	0.564*** (3.80)		
G – Wholesale	-0.019** (-2.16)	Sweden	-1.707*** (-10.33)		
H – Transport	0.019 (0.14)	Denmark	-1.580*** (-10.46)		
I - Accommodation and food	-0.186 (-1.30)	Great Britain	-1.776*** (-11.36)		
J - Information and communication	-0.351** (-2.30)	Bulgaria	0.102 (0.65)		
K – Finance and insurance	-0.523** (-2.52)	Cyprus	0.091 (0.38)		
L - Real estate	-0.377** (-2.01)	Czech rep.	-1.110*** (-7.21)		
M - Professional, scientific and technical activities	-0.377* (-1.88)	Estonia	-2.316*** (-12.22)		
Number of observations	10182	Wald X^2	1199.87	Log pseudolikelihood	-8499.58

Notes: based on data obtained from Flash Eurobarometer 394 survey. Regressions done by ordered logit with standard errors corrected for heteroscedasticity. Variables are all defined in an appendix. (.) denotes z statistics, $^{*}/^{**}/^{***}$ mean significance at the 10%/5%/1% levels of significance.

The lack of standards and regulations may be seen as another hurdle for the commercialisation of innovative products. As it can be seen in Table 3, the lack of standards is a more intensive problem for firms that sell to final consumers and the public sector. Turning to the industrial sector, fewer problems with lack of standards are reported by companies in finance and insurance, information and communication, real estate and wholesale. Furthermore, this problem is significantly more intensive in Portugal.

Table 4: The results of ordered logit regression models – lack of market standards

Difficulties in maintaining intellectual property rights (0 = not a problem, 1 = a minor problem, 2 = a major problem)					
	Coef.	Country fixed effects	Coef.	Country fixed effects	Coef.
Size	0.0001* (1.71)	Belgium	0.090 (0.39)	Latvia	0.325 (1.46)
Year started	0.178*** (2.62)	Denmark	0.028 (0.12)	Lithuania	0.408* (1.82)
Market competition	-0.018 (-0.56)	Greece	0.637*** (2.88)	Malta	0.150 (0.53)
Export share	0.018*** (4.85)	Spain	0.781*** (3.76)	Poland	1.114*** (5.48)
Export share^2	-1.44e^{-6} *** (-3.52)	Finland	0.037 (0.16)	Romania	1.250*** (5.75)
Sell to consumers	0.058 (0.98)	France	0.684*** (3.20)	Slovakia	0.801*** (3.64)
Sell to companies	0.133* (1.90)	Ireland	0.556** (2.50)	Slovenia	-0.240 (-0.99)
Sell to public sector	0.322*** (5.68)	Italy	1.312*** (6.35)	Cut 1	2.693 [0.269]
C – Manufacturing	0.327** (2.17)	Luxemburg	-0.061 (-0.22)	Cut 2	4.020 [0.274]
D - Electricity Gas and	-0.156 (-0.49)	Netherlands	-0.236 (-0.97)		
E - Water and waste	-0.331 (1.13)	Austria	0.616*** (2.78)		
F – Construction	0.173 (1.13)	Portugal	1.960*** (9.37)		
G – Wholesale	0.152 (1.02)	Sweden	0.131 (0.57)		
H – Transport	-0.255 (-1.35)	Denmark	0.643*** (3.05)		
I - Accommodation and food	0.224 (1.20)	Great Britain	0.049 (0.22)		
J - Information and communication	0.563*** (3.06)	Bulgaria	1.320*** (6.15)		
K - Finance and insurance	-0.254 (1.01)	Cyprus	1.050*** (3.34)		
L - Real estate	0.093** (0.39)	Czech rep.	0.430* (1.95)		
M - Professional, scientific and technical activities	0.405** (2.51)	Estonia	-1.147*** (-3.83)		
Arts, entertainment and recreation	0.713*** (2.82)	Hungary	0.165 (0.72)		
Number of observations	10024	Wald X^2	622.77	Log likelihood	-6043.72

Notes: based on data obtained from Flash Eurobarometer 394 survey. Regressions done by ordered logit with standard errors corrected for heteroscedasticity. Variables are all defined in an appendix. (.) denotes z statistics, $^{*}/^{**}/^{***}$ mean significance at the 10%/5%/1% levels of significance.

Finally, we analysed firms' characteristics which lead to problems with intellectual property rights. The results are summarized in the Table 4. It seems likely that older firms and those selling to the public sector have more problems with intellectual property rights. This is particularly evident for information and communication as well as manufacturing and real estate companies. Professionals and firms oriented on science and technology also more often face this kind of problem. Moreover, problems with intellectual property rights are significantly more often reported by firms from Portugal, Italy, Bulgaria, Romania, Poland, Czech Republic, Slovakia, Spain, Greece, France, Denmark, Austria, France and Ireland.

In the next part of the analysis we focus our attention on testing the actual effect of selected problems on the commercialisation of innovations. The results, which were estimated by logit and ordered logit with two different dependent variables, are summarized in Table 5. The dependent variable in first two regressions is a dummy variable taking a value of 1 for those firms that innovate but do not commercialize that innovation. Here we analyse the factors affecting the probability that the firm does not want to or fails to commercialise its innovation. Of course the main focus is on the variables that are related to standards or regulations.

The dependent variable in the next pair of regressions relates to the perceived share of turnover gained due to innovations. This variable is measured on an ordinal five point scale from 0% (coded as 1) to 76-100% (coded as 5). By using ordered logit regression models with this dependent variable we are able to identify those factors affecting the commercial success of innovation. In addition to the variables at the level of individual firms we also applied country-specific average variables related to standards and regulations in order to eliminate potential endogeneity problems. All variables are defined in more detail in a data appendix.

The results for the first set of regressions, suggest that more expensive or more complex standards increase the probability that a firm will fail to commercialise its innovation. This result is also evident in the case of the country-specific averages. Higher cost of standards or complexity of standards in a certain country could lead to a higher proportion of firms that innovate but do not commercialise. On the other hand, a lack of market standards in the country seems to have a significantly negative effect. However this effect has been found only at the country level, but does appear in the case of the variable which measure firms' individual perception of this problem.

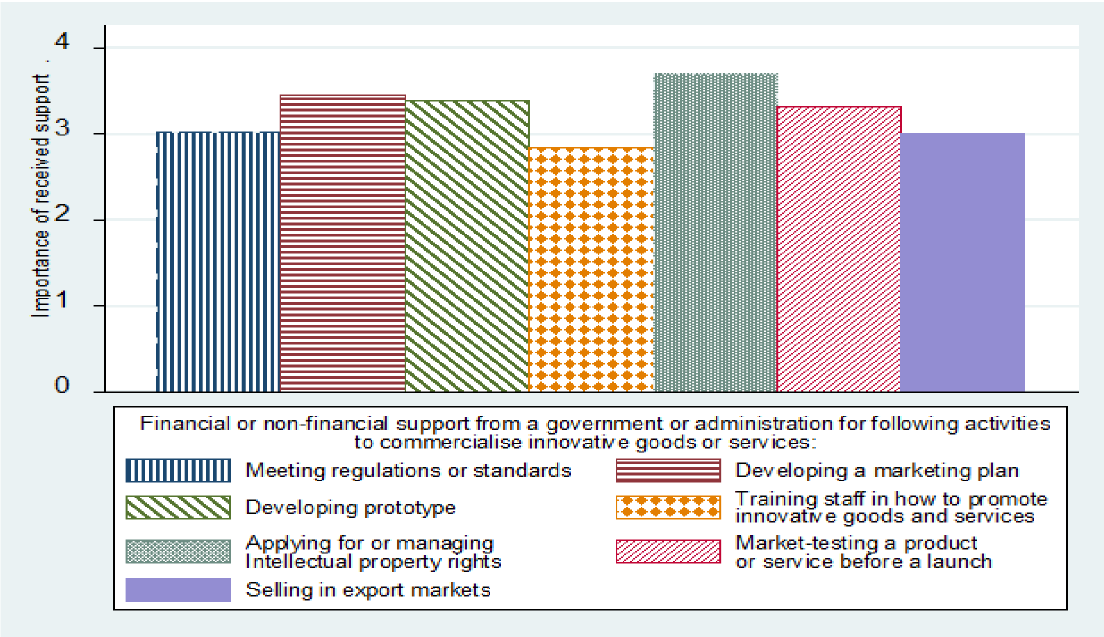
The situation will partially change when we take into account the difference in commercial success of the innovation measured by the share of total turnover. In this case we take into account only those firms that innovate in the selected period of the time. As can be seen from the second set of regressions in Table 5, the cost or complexity of standards does not have any significant effect. On the other hand, the lack of market standards at country level does have a significantly negative effect on the share of turnover induced by innovation. It seems that lack of standards in the country could decrease the number of those firms that failed to commercialise their innovation, but at the same time decrease potential turnover arising from commercialised innovation. Thus, it is easier for all firms to commercialise innovation in a business environment with less standards or regulations, but the return of the innovation could in these circumstances be significantly lower. Thus standards could be seen as some kind of barrier, but when this barrier is crossed the benefits will appear in the form of higher potential revenue. Similarly, the perceived problems with maintaining intellectual property rights could be seen as the factor supporting commercial success of innovation. Those firms that have to deal with intellectual property rights increase their probability of getting higher revenue from the commercialised innovation.

Table 5: The results of logit and ordered logit regressions

Dependent variable:	Innovate but not commercialize			Share of turnover due to the innovation		
	(1)		(2)	(3)		(4)
	coef.	odds ratio	coef.	coef.	odds ratio	coef.
Size	$-3.99e^{-6}$ (-0.09)	0.999	0.00001 (0.25)	0.00002 (0.40)	1.00002	0.00002 (0.27)
Year started	0.002 (1.35)	1.036	0.050 (0.60)	0.694*** (7.23)	2.002	0.121*** (6.84)
Market competition	-0.033 (-0.91)	0.967	-0.034 (-0.92)	0.123*** (2.75)	1.131	0.121*** (2.64)
Export share	0.002 (1.35)	1.002	0.0005 (0.38)	0.005*** (4.25)	1.005	0.006*** (4.59)
Sell to consumers	0.007 (0.10)	1.007	-0.060 (-0.87)	-0.028 (-0.40)	0.972	-0.344 (-0.46)
Sell to companies	-0.019 (-0.02)	0.998	0.008 (0.09)	0.244** (2.53)	1.276	-0.292*** (2.97)
Sell to public sector	0.110* (1.68)	1.116	0.108 (1.62)	0.144** (2.11)	1.155	0.161** (2.32)
Manufacturing	0.024 (0.25)	1.025	0.018 (0.18)	0.239** (2.23)	1.270	0.268** (2.47)
Retail	-0.116 (-1.28)	0.891	-0.162* (-1.67)	0.239** (2.35)	1.271	0.290*** (2.82)
Services	-0.163* (-1.77)	0.849	-0.160* (-1.71)	0.226** (2.09)	1.253	0.269** (2.47)
Professionals and science	0.277** (2.46)	1.320	0.261** (2.29)	0.290** (2.18)	1.336	0.255* (1.89)
Lack of finance	0.164*** (4.03)	1.178	0.147*** (3.54)	0.021 (0.48)	1.021	0.037 (0.83)
Lack of marketing	0.182*** (3.62)	1.200	0.187*** (3.64)	0.053 (1.04)	1.054	0.041 (0.78)
Cost or complexity of standards	0.112*** (2.67)	1.119	0.111** (2.59)	0.015 (0.34)	1.015	0.020 (0.43)
Market dominated by competitors	-0.012 (-0.29)	0.988	-0.010 (-0.24)	-0.026 (-0.60)	0.974	-0.370 (-0.82)
Low demand for your goods or services	-0.098** (-2.27)	0.907	-0.110** (-2.45)	-0.111** (-2.24)	0.895	-0.119** (-2.38)
Maintaining IPRs	0.010 (-0.18)	0.990	0.253 (0.45)	0.125** (2.31)	1.133	0.111** (2.01)
Lack of standards or regulations	0.047 (0.99)	1.049	0.451 (0.94)	0.009 (0.18)	1.009	0.013 (0.25)
Weak distribution channels	0.095* (1.91)	1.010	0.116** (2.29)	0.172*** (3.37)	1.188	0.158*** (3.03)
Country-specific variables:						
Cost or complexity of standards or regulations – country average	0.634*** (2.67)	1.886		0.360 (1.31)	1.434	
Lack of standards or regulations – country average	-0.751*** (-8.74)	0.472		-0.521** (-2.18)	0.594	
Countries fixed effects			YES			YES
Constant	-2.596*** (-8.74)	0.075	-2.350*** (-9.86)			
Observations	9468		9468	4957		4957
Log likelihood	-3835.79		-3755.66	-4615.32		-4572,90
Wald X^2	119.63		280.17	140.27		225.24

Notes: based on data obtained from Flash Eurobarometer 394 survey. Regressions done by logit and ordered logit with standard errors corrected for heteroscedasticity. Variables are all defined in an appendix. (.) denotes z statistics, $^{*}/^{**}/^{***}$ mean significance at the 10%/5%/1% levels of significance. Countries fixed effect included in regressions (2) and (4).

In order to reduce problems with commercialisation, financial or non-financial support from government or administration are often used. In this part of the analysis we try to evaluate the actual effect of different types of support. Firms that receive any type of support have to indicate whether this support has been important for the commercialisation of their innovations on a six point scale, where 1 represents that innovation would have been commercialised even without the support and 6 means that support was indispensable for commercialising the innovation. The average scores for each kind of support are graphically illustrated in Figure 6. The support for applying for or managing intellectual property rights seems to be the most useful according to firms. On the other hand support for meeting regulations or standards appears to be less important for most firms.



Source: Authors calculations based on data obtained from Flash Eurobarometer 394 survey.

Figure 6: The importance of different support types for commercialisation of innovation

The potential effects of each kind of support on commercial success of innovation measured by share of turnover due to innovation have been examined by an ordered logit regression model. The results of this model are shown in Table 6. As can be seen, there is a statistically significant and positive effect of the support for applying for or managing intellectual property rights. The positive effect of other types of support is rather questionable. The support for developing a marketing plan and selling in export markets is significant only at 10% level of significance.

Table 6: Results of ordered logit model – the effect of different support

Dependent variable:	Share of turnover due to innovation	
	coef.	Odds ratio
Size	9.64e-6 (0.15)	1.00001
Year started	0.703*** (7.44)	2.019
Market competition	0.083* (1.92)	1.086
Export share	0.013*** (3.07)	1.013
Export share^2	-0.00008* (-1.88)	0.999
Sell to consumers	-0.034 (-0.49)	0.967
Sell to companies	0.327*** (3.50)	1.387
Sell to public sector	0.161** (2.45)	1.175
Manufacturing	0.266** (2.57)	1.305
Retail	0.251** (2.56)	1.285
Services	0.326*** (3.33)	1.385
Received support for:		
Meeting regulation or standards	0.015 (0.10)	1.015
Developing marketing plan	0.316* (1.85)	1.372
Developing prototype	0.220 (1.36)	1.246
Training staff how to promote	0.087 (0.63)	1.091
Applying for or managing IPRs	0.863*** (3.46)	2.370
Market-testing	0.251 (1.32)	1.285
Selling in export markets	0.259* (1.71)	1.296
Other	0.084 (0.63)	1.087
Countries fixed effects included	Yes	
Observations	5431	
Log likelihood	-5034.61	
Wald X2	268.36	

Notes: based on data obtained from Flash Eurobarometer 394 survey. Regression done by ordered logit with standard errors corrected for heteroscedasticity. Variables are all defined in an appendix. (.) denotes z statistics, $^{*}/^{**}/^{***}$ mean significance at the 10%/5%/1% levels of significance. Countries fixed effect included in regression.

5 Conclusions

The analysis has shown that costly and too complex standards could represent an obstacle to the commercialisation of innovations. On the other hand, too little standardisation could have a negative effect on potential revenues from the commercialised innovation. These results may relate to the role of standards in providing a level playing field, in particular by removing problems posed by asymmetric information facilitating the entry of inferior quality goods into the market. Thus, standards are some kind of barrier, but once innovative products pass through this barrier, higher potential revenue from this innovation could be the reward.

We have identified significant differences between countries. We have also provided evidence that in part these differences are related to the standardisation environment within countries. The cost and complexity of standards appears to be a problem especially in Portugal, Italy and Poland. This is an issue these, and indeed other governments should address. However, this problem is significantly less intensive in several sectors such as wholesale, information and communication and real estate. On the other hand, a lack of standards could be a problem especially for the firms selling to consumers and the public sector and also again for firms from Portugal. Lack of standards is less evident as a constraint in finance and insurance, information and communication, real estate and wholesale. Hence the answer to our research question is that standards, in some circumstances and if complex, can provide a barrier to innovation. But also the lack of standards can also prove to be a barrier. This should not be surprising. Standards create another regulatory hurdle innovations must clear before being successfully marketed. But standards also help new products and new firms become established by, for example, signalling quality. The conclusion also has similarities with that of Pelkmans and Render (2014) with respect to EU regulation in general that at times it be significantly stimulate innovation. However, more prescriptive regulation tends to hamper innovative activity.

The effect of intellectual property rights on the commercialisation of innovation is very similar. However, this problem is more significant in the case of older firms and those operating in the fields of information and communication, manufacturing and real estate. The problem with intellectual property rights is also evident in professionals and firms oriented on science and technology. Those firms that have initial problems with intellectual property rights or receive government or administration support for applying for or managing intellectual property rights have more commercial success with their innovations, receiving a higher share of turnover from innovative goods or services.

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Appendix 1 *Definition variables used in regression models*

Variables	Description of variables and their coding
Innovate but not commercialize	Which of the following best describes the commercialisation of innovation in your company? We have innovations, but we do not commercialise them (Coded 1) We have innovations and we commercialise them (Coded 0)
Share of turnover due to innovation	Approximately what percentage of your company's turnover was due to innovative goods and services? 0 % - coded 1; Between 1 and 25 % - coded 2; Between 26 and 50% - coded 3; Between 51 and 75 % - coded 4; Between 76 and 100% - coded 5.
Constraints to commercialisation of the company's innovative goods or services:	
Cost or complexity of standards and regulations	Coded as follows: not a problem at all = 0 a minor problem =1 a major = 2
Lack of standards or regulations	
Difficulties in maintaining intellectual property rights	
Lack of financial resources	
Lack of marketing expertise	
Market dominated by established competitors	
Low demand for your goods and services	
Weak distribution channels	
Has your company received financial or non-financial support from government or administration for any of the following activities to commercialise your innovative goods or services?	
Meeting regulation or standards	Coded as: Yes = 1; No =0
Developing marketing plan	
Developing prototype	
Training staff how to promote	
Applying for or managing IPRs	
Market-testing	
Selling in export markets	
Other support	
Size	Number of employees. (Most are small firms, the median is 13 and the 90th percentile 134).
Year started	Coded 1 if the firm was started before 1 January 2008, 2 if started between 1 January 2008 and 1 January 2013 and 3 if started after January 1 2013
Export share	The proportion of 2013 turnover which was came from exports
Sell to Consumers	Coded 1 if the firm sells to individual consumers, otherwise zero
Sell to companies	Coded 1 if the firm sells to other companies, otherwise zero.
Sell to Government	Coded 1 if the firm sells to public sector organisations, otherwise zero
Manufacturing	Coded 1 if in NACE category C
Retail	Coded 1 if in NACE category G
Services	Coded 1 if in NACE categories H/I/J/K/L/M/N/R

Source: Authors based on the Flash Eurobarometer 394 survey.

IEEE IP Policy Update Under the Scrutiny of the EC Guidelines on Horizontal Cooperation

Olia Kanevskaia, Nicolo Zingales

TILEC, Tilburg University

o.s.kanevskaia| n.zingales @uvt.nl

***Abstract**: In 2015, the Institute of Electrical and Electronics Engineers' Standardization Association (IEEE-SA) made some controversial changes to its patent policy. The changes include in particular a prescribed method of calculation of FRAND royalty rates, and a request to members holding a standard essential patent (SEP) to forego their right to seek an injunction except under limited circumstances. The amended patent policy was adopted by the IEEE Board following favorable business review letter by the US Department of Justice, which found any potential competitive harm from the policy to be outweighed by potential pro-competitive benefits.*

In this paper, we examine whether these changes might impact the regime of "safe harbor" set up for standardization agreements under EU competition law, in particular the guidelines provided by the European Commission. Given the importance placed by the guidelines on procedural safeguards to prevent SSO activities from resulting in anti-competitive cooperation, we contrast the ad hoc *process leading to this policy change with the procedures in place for regular standard-setting activity.*

1 Introduction

The past decennia witnessed continuous development of technical innovation, which brought a fundamental change to our quotidian life. As a consequence, technical standards significantly raised in prominence, allowing for the widespread use of the emerged technologies. While those standards are typically defined as sets of technical specifications that provide for a common design for a product or a process, their role goes far beyond the mere codification and description of technical parameters, and addresses the core aspects of the market- and technology-shaping.[1] This is especially the case for standards developed in the Information Technology (IT) sector, categorized by the rapid pace of innovation and the fastest growth in terms of international trade.[2] Yet, the application of standards may be burdensome, once they contain proprietary technologies patented by their developers, which is the case for many ICT and telecommunication standards.[3]

With the increasing importance of the commercial values attached to the patented technologies, the antitrust concerns arising from the implementation of patented technical solutions into standards has often been a topic for disputes.[4] Those concerns are especially

* This paper is a part of a longer contribution, which discusses the substantial modifications of the IPR Policy and performs a more elaborative analysis (Olia Kanevskaia, Nicolo Zingales, *The IEEE IPR Policy Update under the Lens of EU Competition Law,* TILEC Discussion Paper 2016/008, available at https://www.tilburguniversity.edu/research/institutes-and-research-groups/tilec/research/publications/discussion-papers/.)

[1]Baron J. and Pohlmann T., (2013, November). Who cooperates in standards consortia – rivals or compelementors? *Journal of Competition Law and Economics 9(4)*, pp. 905- pp.929, 905-906

[2] See Annex 1 to the ITU Resolution 71 (Rev. Busan, 2014)

[3] Geradin, D., (2013, November). The European Commission Policy towards the Licensing of Standard-Essential Patents: Where Do We Stand? *Journal of Competition Law and Economics, 9(4),* pp. 1125 – pp. 1145. 1126

[4] See, for instance, Chiao, B., Lerner, J. and Tirole, J., (2007). The Rules of Standard-Setting Organizations: an empirical analysis. *RAND Journal of Economics, 38(4),* pp.905 -pp.930

aggravated, when the definition and implementation of a particular standard is dependent on patents that are essential for it. In principle, the owners of such standard-essential-patents (SEPs) are entitled to demand royalties each time that standard is practiced. To prevent such patent owners from abusing their privileged position by demanding excessive royalties from standard implementers, Standard-Setting Organization (SSOs), which serve as a main platform for coordinated standards development, adopt specific rules defining the procedures that must be followed within the particular SSO in relation to SEPs. Most commonly, this is done through the obligation to disclose the existence of SEPs and the request that SEP holders commit to license them under certain (typically F/RAND[5]) terms.

Such rules they strive to balance the freedom of patent owners to collect royalties with the need to prevent the abuse of their powers. However, SSOs vary as to the scope and nature of the obligations they impose on SEP owners. Importantly, tilting the balance in favor of one or the other end of the spectrum can have serious consequences for innovation, as it may reduce the incentive of technology developers to join the organization. For this reason, SSOs' IP policies have been a controversial subject in academic studies on the governance of standard-setting.[6]

One of the recent subjects of discussion concerns the Policy Update of the Institute of Electrical and Electronics Engineers' Standardization Association (IEEE-SA). The Update was intended, *inter alia,* to minimize the risk of patent holdup and address the challenges arising from the vagueness of F/RAND commitments,[7] facilitating negotiations between technology owners and implementers. In brief, four fundamental changes were introduced in the new Policy following its revision processes: (1) obligation for patent holders to license their patents for any 'Compliant Implementation', meaning any product (e.g., component, sub-assembly, or end-product) or service that conforms to any mandatory or optional portion of a normative clause of an IEEE Standard"; (2) prohibition for patent holders to seek injunctions[8] for breach of their ownership rights, after issuing a Letter of Assurance (LOA)[9]; (3) modification with regard to determination of a 'Reasonable Rate',[10] and (4) clarification that SEP holders can require reciprocity with regard to the licensee's patents that are essential to the same standard, but not with regard to non-SEPs or patents that are essential to other standards.

The Policy Update has been subject to much critique, both for its controversial substantive amendments and the dubious process of its revision. Whereas examining the policy modification is not the aim of this paper, the focus lies rather on the *procedures that* led to the approval and adoption of the new policy. To this extent, this paper seeks to examine whether

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[5] F/RAND is used here to reflect the different nomenclature used in United States (RAND) and Europe (FRAND) to refer to the same concept. The two terms can be used interchangeably.

[6] I.e. Curran, P.D., (2003). Standard-Setting Organizations: Patents, Price Fixing, and Per Se Legality. *The University of Chicago Law Review, 70,* pp. 983- pp.1009; Jakobsen, K.A., (2004). Revisiting Standard-Setting Organizations' Patent Policies. *Northwestern Journal of Technology and Intellectual Property, 3(1),* pp.43 – pp.60; Lemley, M.A. (2002), Intellectual Property Rights and Standard-Setting Organizations. *California Law Review, 90(6),* pp.1891 – pp.1889

[7] See the IEEE Request for Business Review letter (2014, September), retrieved from https://www.justice.gov/sites/default/files/atr/legacy/2015/02/17/311483.pdf, 11-12. Moreover, clarification of F/RAND had moreover been encouraged by regulators in the EU and US, as well as by retail companies alleging to have been involved in disputes for disproportionate royalty requests in relation to the use of a standard

[8] More specifically, the policy refers to a Prohibitive Order, which is defined in para 6.2 as "an interim or permanent injunction, exclusion order or similar decision that limits or prevents making, using or selling a compliant implementation".

[9] IEEE-SA Standards Board Bylaws, para 6.2 provides an exception for this provision, namely when 'the implementer fails to participate in, or to comply with the outcome of, an adjudication, including an affirming first-level appellate review (..) by one or more courts that have the authority to: determine Reasonable Rates and other reasonable terms and conditions; adjudicate patent validity, enforceability, essentiality, and infringement; award monetary damages; and resolve any defenses and counterclaims'

[10] *Ibid* para 6.1

the revised IEEE IP Policy can fit within the framework carved out by EU Competition law for standardization activities. In doing so, it will firstly familiarize the readers with the governance of the IEEE (section 2), followed by it a detailed explanation of the IEEE-SA standard-setting process (section 3). Furthermore, section 4 will discuss the exact process of Policy revision, and its approval by the higher hierarchical bodies. Those processes will be ultimately scrutinized for their compliance with the principles of the EC Guidelines for Horizontal Cooperation in section 5. The last section will summarize the paper with some conclusive remarks.

2 An introduction to the IEEE and its governance structure

The IEEE, a privately-driven organization incorporated under the US law, is one of the largest technical professional societies. With around 450.000 members from nearly 160 countries, the IEEE is actively engaged in the various branches of modern engineering and ICT industry. According to its mission statement, the activities of the Institute are predominantly aimed at fostering innovation and contributing to the global technical progress.[11] The Institute serves as an overarching organization for a large number of societies, boards and committees, each dedicated to a specific issue or territory and often having their own administrative and management settings.

The IEEE's largest contributions to the technology advancing derive from the activities of its Standardization Association (IEEE-SA). A considerable number of worldwide applicable standards for wireless telecommunications was developed under coordination of the IEEE-SA platform. For instance, standardization of the bottom of two layers of ISO/OIS protocol stack led to formation of IEEE 802.15.4[12] and subsequently, the ZigBee technical specification, which allowed low-cost and low-speed data transfer between devices. This short-range communication system intends to provide applications with relaxed throughput and latency requirements in WPAN, and is commonly used in traffic management systems and electrical meters with in-home displays.[13] Likewise, the set of specifications for Wi-Fi chipsets[14], also referred to as the IEEE 802.11 WLAN standard, enabled the interconnection of electronics technologized via wireless telecommunications. Like a number of other fundamental IEEE technical specifications, the mentioned standards are subject to the industry-wide commitment and proved to be almost indispensable in the modern reality.

The fact that the IEEE is accredited by the American National Standards Institute (ANSI)[15] denotes that standards endorsed within its forum are classified as American National Standards (ANS), and hence enjoy certain authority within business and government at both national and international levels.[16] Once a significant modification of standards development procedures has taken place, the SSO at issue should re-apply for accreditation by the ANSI's Executive Standards Council (ExSC),[17] which examines whether the altered procedures still comply with the requirements of due process,[18] and thus whether the organization at issue can maintain its status of ANS developer. Losing ANSI's accreditation might severely harm

[11] See the mission statement at http://www.ieee.org/about/vision_mission.html and Article 1 IEEE Constitution
[12] Buratti, C. e.a., (2009, August). An Overview on Wireless Sensor Networks Technology and Evolution. *Sensors, 9*, pp.6869 – pp.6896
[13] http://www.zigbee.org/ accessed on 8 March 2016
[14] http://www.ieee802.org/11/ accessed on 9 March 2016
[15] *Above n 7,* 2
[16] '…ANSI accreditation and ANSI standards are sought by business, government and users, and are relied upon by the courts because the ANSI process ensures openness, due process and consensus…' from www.ansi.org accessed on 5 April 2016
[17] Section 6.10 ANSI Constitution and By-laws
[18] See ANSI Essential Requirements: Due Process Requirements for American National Standards, edition January 2015 at www.ansi.org/essentialrequirements accessed on 15 April 2016

SSO's international reputation, and consequently limit its participation in global standard-setting and the development of national standard-related policies.

As mentioned *supra,* the recent modification of the IEEE IP Policy, although not contested by the ANSI,[19] have been subject to much critique with regard their amendment process. Yet, in order to assess the revision in a proper context, it is necessary to understand the Institute's regulatory and operational framework.[20]

Being a specialized organizational unit ('Major Board')[21] operating within the Institute's framework, the IEEE-SA has its own governance system and enjoys a high degree of authority over the matters related to standardization.[22] Its strong connection to the main organization is apparent, inter alia, from the fact that the Standards Association bears responsibility towards the IEEE Board of Directors.[23] Chaired by a President, who acts as a contact point for external stakeholders,[24] the IEEE-SA is governed by its own Board of Governors (BOG) that in turn establishes the Association's policies and delivers the financial oversight of the Association's activities.[25] A maximum of 15 BOG members is elected every two years by the IEEE voting members, who should also hold the membership of Standards Association.[26] Each year, the BOG further appoints the Standards Board (SASB), consisting of voting members of both IEEE-SA and IEEE.[27]

In turn, the SASB plays an important role in the processes of development and approval of IEEE draft standards. Those activities are divided between the SASB committees, each of them entrusted with specific tasks. For instance, standards development is subject to the throughout appraisal of the Patent Committee (PatCom), which provides oversight on the use of patented technologies in the IEEE standard-setting.[28] This Committee is composed of at least four but not more than six persons, who must be voting members of the SASB or the BOG. Except for one *ex officio* member, all PatCom participants, including the chair, have a power to vote. Besides its function as the reviewer of standard-setting processes, the PatCom is responsible for defining the Institute's IP Policy, although its contributions take form of non-binding recommendations to the SASB.

Modifications in the IEEE-SA's regulatory framework involve participation of the other union of SASB, namely the Procedures Committee (ProCom). This committee is as well appointed by the SASB and is composed of at least six members of it.[29] The engagement of the ProCom in the processes of alteration the IEEE-SA's bylaws is not obligatory: for instance, the Updates of the IEEE patent Policies in 2007 happened entirely within the PatCom.[30]

Remarkably, many analyses of the IEEE-SA activities lack the description of the actual participants of standard-setting, their powers and degrees of influence in technology and

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[19] The re-accreditation of the IEEE as an ASD after the revision of its IPR Policy was appealed 9 February 2016, and subsequently rejected by the ANSI ExSC Appeals Panel

[20] '…Economic effects of standardization processes and the incentives of the participating parties depend upon the complex institutional setting of SSOs…', Baron, J and Gupta, K, (2015, March). Unpacking 3GPP Standards. Retrieved from http://www.law.northwestern.edu/research-faculty/searlecenter/innovationeconomics/data/technologystandards/

[21] I-303 IEEE Bylaws

[22] *Ibid,* I-300:6

[23] *Ibid* I-300

[24] 4.2.2.1 IEEE-SA Operations Manual

[25] *Above n 21*

[26] *Ibid*

[27] Article 5.1.2 EEE Standards Association Operations Manual

[28] 4.2.5 IEEE-SA Standards Board Bylaws

[29] *Ibid* 4.2.1

[30] see request for Business Review Letter p 3-4

management decision-making[31]. In this regard, the initial step to uncover the actors of standardization is to scrutinize the legal documents of the organization concerned. As recognized *supra*, the IEEE and its Standards Association have different membership rules: whereas the legal framework of the IEEE allows only individuals to become a member, the Standards Association accepts a great variety of players with demonstrated interest in standards activities, including governmental agencies on different state-organizational levels, trade associations, commercial entities[32] and individuals.[33] Although the latter do not necessarily have to be affiliated with the IEEE, a prior membership of the Institute is indirectly encouraged by the lower fees.[34] In turn, the dues for the entity –members vary according to their annual revenue and the nature of membership (basic or advanced). Academic institutions, NGO's and governmental agencies are subject to the smallest entity-membership contributions.[35] Such fee allocation can be categorized as proportional, ensuring that requirements for joining the SSOs be kept at a minimum.

The next step of this analysis is to understand that the distinction between individual and entity-members plays a crucial role in choosing the methods of standards development. Individual members are empowered to vote only in individual-based procedures: for instance, the 802.11 WiFi standard mentioned in section 2 of this paper was developed under the individual method. Representatives of public agencies and private enterprises can respectively take part in balloting processes of standards developed under the entity-based method[36] introduced in recent decennia.

Yet, contrary to the practice of many other SSOs[37], the members of the IEEE-SA are not (always) those who stand behind its standard-setting, and the actors involved in standardization are not (always) the members of the forum - institution. To a certain extent, the procedural rules of the Standards Associations allow every interested party to take part in the formulation of particular standards or technical specifications of their interest.

3 IEEE-SA's standard-setting procedures

Since the formulation, reviewing and amending of standards and technical specifications are entirely entrusted to the IEEE-SA, the IEEE standard development processes are subject to the rules drawn by the IEEE-SA's legal framework. In this regard, much as the meetings within the IEEE, all IEEE-SA discussions are guided by the Robert's Rules of Order.[38] As we will see in the following section, this fact is of cardinal importance, since the mentioned document sets the rules for conducting business at meetings of the IEEE's boards and committees. Those rules concern, *inter alia,* the procedures for proposing motions and (secret) voting

[31] In the context of this paper, technology decisions imply the inclusion or exclusion of particular intellectual property/patented technology in the standards' description, an considerations related to the technical implementation of the standard; other decisions would be presumed to be management decisions (i.e. submitting the draft for the next stage)
[32] Interestingly, this requirement does not apply to the for-profit enterprises. The list of corporate members of the IEEE-SA can be found at http://standards.ieee.org/develop/corpchan/mbrs1.html accessed on 1 March 2016
[33] I-403 IEEE Bylaws; the IEEE-SA recognizes the following membership qualifications: individuals, non-for profit enterprises and for-profit enterprises
[34] 53 US $ against 245 US $ for external parties; see 6.2 IEEE-SA Operations Manual
[35] 6.2 IEEE-SA Operations Manual
[36] *Ibid* 6.3.1
[37] For comparison, participation in the standard-setting of the ETSI and the ITU-T is conditional upon the membership of those organizations
[38] Those typically govern meetings, debates and balloting performed by groups in organizations and assemblies; for the application of the Robert's Rules of Order to the IEEE and the IEEE-SA activities, see I-300:1 IEEE Bylaws and 5.1 IEEE-SA Standards Board Bylaws

In general, the process of standards development at the IEEE-SA can be divided into three stages: the proposal to standardize, the actual work on defining technical conditions and requirements to be included in the prospect standard, and the approval of standard's draft.[39] Pursuant to the legal documents governing the Institute's standardization activities, each of the three stages should be guided by the principles of due process, openness, consensus, balance, and the right of appeal.[40] This is also apparent from the US Standards Development Organization Advancement Act of 2004, which emphasizes that the adherence to those principles is achieved by informing all stakeholders affected by the particular standards about the development activity, providing opportunities to participate in standardization, avoiding dominance of a single interest group, providing access to relevant information, reaching a substantial agreement during negotiations and allowing the expression and consideration of stakeholders' positions.[41] Compliance with those principles ultimately triggers a presumption that the resulting standards do not constitute (potential) barriers to international trade and development.[42]

3.1 First stage: standardization proposal

Initiation of standardization project can be considered the most vital stage of the process. It sets the course for the future work on standard's formulation by ensuring that the proposed project is not only technical and financially achievable, but also falls within the purpose of the IEEE activities and benefits the society. As the contributors to standard's development and their willingness to actively participate in the relevant meetings should be determined prior to the launching of a standardization project, this stage would typically entail a significant amount of pressure by participating companies. It is thus quite conceivable that suggestions or choices with regard to the inclusion of certain technologies are already being made *prior* to the official authorization of the standard's development.

The regulatory framework of the IEEE-SA allows everyone who recognizes a need for standardization of a certain technical concept or methods, to bring forward a standardization proposal.[43] Parties interested in the project at issue, are then invited to collaborate in the Study Groups[44], whose main task is to ensure that there is sufficient interest and enough (financial) resources to launch the proposed project. In their assessment, those Groups also take into account the existence of related standards and the necessity of coordination within or outside the Institute. Remarkably, the IEEE-SA Antitrust and Competition Policies already apply at this stage, along with the requirements to allow contributions from every Study Group participant[45]. Although this phase of standard development does not explicitly calls for disclosure of intellectual property, any suggestions from participants with regard to it are greatly encouraged.

Study Groups act under the supervision of a Sponsor, an organization that determines the technical content and bears the overall responsibility for the dedicated standardization project.

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[39] This division is rather simplified, as each of the three stages is typically comprised out of more phases

[40] 2.1 IEEE-SA Standards Board Bylaws, 5.1 IEEE-SA Standards Board Operations Manual, 5.3.3. IEEE-SA Standards Board Operations Manual See, for instance, What do you need to know about IEEE Standards and the Law https://standards.ieee.org/develop/policies/stdslaw.pdf accessed on 8 March 2016; see also *above n 8,* 2

[41] Standards Development Organization Advancement Act of 2004, (2004, June). Title I, Public Law 108 - 237 Sec. 101 (5)

[42] The decision Of The Committee On Principles For The Development Of International Standards, Guides And Recommendations With Relation To Articles 2, 5 And Annex 3 Of The Agreement names the following principles: transparency, openness, impartiality and consensus, effectiveness and relevance, coherence and addressing concerns of developing countries

[43] The Standards Development Lifecycle, ' Who can Participate?' https://standards.ieee.org/develop/participate.html accessed on 20 February 2016

[44] A Study Group is not required to be formed from the new participants, as new PARs can be developed by already existing Groups (i.e. from the previous standardization projects)

[45] IEEE-SA Study group Guidelines https://standards.ieee.org/develop/corpchan/studygrp.pdf accessed on 20 February 2016

[46] When evaluating the preparatory work of the Study Group, the Sponsor particularly considers, *inter alia,* the potential market acceptance of the standard, its technical feasibility and the realistic scope and objective, what reveals the market-driven character other IEEE-SA standardization. Traditionally, the Sponsors for IEEE standards are IEEE Societies and Committees, Standards Coordinating Committees (SCCs), the Corporate Advisory Group[47] or, in case those cannot assume the duty, the Standards Board.[48] This indicates that, although standardization activities do not take place within the institutional framework of the IEEE, its bodies are directly involved technical and financial coordination of standards development.

Although the work of the Study Groups is consensus-based, there might be cases when a decision needs to be taken by majority voting. The determination of the voting quorum in order for the ballot to be valid is left to the Sponsor. The IEEE-SA Study Group Guidelines recommend a minimum of five persons to participate for valid voting in individual-based Study Groups, and a minimum of 3 three entities for entity-based Study Groups; the approval percentage for both standard-setting methods is 75% of votes in favor of a motion. In general, there are no restrictions with regard to motions on which participants can vote.

In this first phase of standard-setting, a Study Group drafts a Project Authorization Request (PAR), which is highly detailed legal document stating the reasons and intentions of the related standardization project. Next to its symbolic role as the permission to proceed with the technical work, a PAR serves as a means by which participants assign the copyright to, and the indemnification from the IEEE.[49] Once prepared, the PAR is submitted by the Sponsor to the New Standards Committee (NesCom) [50], which verifies whether the proposed project falls within the scope and the purpose of the IEEE, is assigned to a proper Sponsor and if all interested parties are appropriately represented in the processes. In this capacity, the NesCom can pass comments on the PAR, which should be respectively taken into account by the relevant Study Group. The technical process of defining and formulating a standard starts directly after the formal approval of the PAR by the IEEE-SA Standards Board, and should take no longer than four years.[51]

3.2 Second stage: definition of technical requirements

The PAR approval inaugurates the following stage of the standard-setting, and defines the final structure and composition of the Working Group charged with coordination of the technical activities. Much as the Study Groups in the first phase of standard-setting, the Working Groups are open to anyone with the relevant technical expertise, knowledge and dedicated interest in the project.[52] In many cases, a Study Group that drafted the PAR would be converted into a Working Group after the project is authorized. Each Working Group is thus tailor-made for a particular set of standards. Accordingly, amendments or revisions of the existent technical specifications would be processed by the same Working Group drafting them. Each proposal to alter the standard should undergo the same procedure as the proposal for a new standardization item, including the drafting of the PAR and its subsequent approval by the IEEE-SA Standards Board.

[46] Article 5.2.2 IEEE-SA Standards Board Bylaws and Article 5.1 IEEE-SA Standards Board Operations Manual
[47] The IEEE-SA Corporate Advisory Group may only act as a Sponsor for entity-based Study/Working Groups together with another IEEE Sponsor or when another Sponsor cannot immediately be determined; see IEEE-SA Study Group Guidelines
[48] For the current list of Sponsors, see https://development.standards.ieee.org/pub/view-sponsor-pnps accessed on 20 February 2016
[49] The Standards Development Lifecycle, 'Submitting a Project Request' https://standards.ieee.org/develop/par.html accessed on 8 March 2016
[50] 4.2.2 IEEE-SA Standards Board Bylaws; The NesCom is comprised of IEEE members, of which four need also to be voting members in the Standards Board. This again points toward an active role of the Institute at this stage
[51] In certain cases, extensions are possible upon the request of the Sponsor and the approval from the NesCom
[52] *Ibid above n 41*

The detailed work on the standard document is typically divided into several phases: upon the drafting of a scope and purpose statement, the Working Group creates an outline, which defines the structure for the standard. The subjects in the outline would later become the clauses and subclauses in the final document. The drafting work is then split among the Working Group's members, who in turn work on their section outside the formal meetings. From that time on, the Working Group is convened together to resolve problems occurred during the drafting work. The meetings may be conducted both virtually and in person. In the latter case, the Working Groups might charge a fee in order to cover the necessary meeting expenses. The draft document is composed together by a technical editor.[53]

Whether the participants represent their own interests or the interests of the organizations with which they are affiliated depends on the method according to which the Study – and consequently, Working Groups are operating.[54] Although the engagement in *individual* standardization projects does not require a prior membership of the IEEE or the IEEE-SA[55], participants wishing to take part in the balloting processes are subject to additional organization fees.[56] Such mechanism does not apply to the Working Groups of the entity-based projects, which only accept one representative per organization that possess the corporate membership of the Standards Association.[57] The standard-developing meetings should ensure broad and balanced representation of all interested parties: in this endeavor, the members of the IEEE can be approached by reason of their expertise in matters related to standardization project at stake. Likewise, in order to attract experts from outside the Institutions, a call for participation can be issued in coordination with the IEEE-SA Media Contact. The interested parties are ultimately informed about standardization progress by the minutes of the meetings, publically accessible on the website of the Working Groups.[58]

The IEEE-SA seeks to encourage the disclosure of (potentially) essential patented technology at the earliest stage of standard development. In principle, each Working Group meeting commences by the statement concerning the IEEE-SA patent policy and a call to identify or disclose the holders of patents, which the meeting participants believe to be essential for the functioning and implementation of the standard at issue.[59] Those (potential) patent-holders may subsequently be asked to submit a Letter of Assurance (LoA) to the IEEE, a document stating the submitter's position with respect to ownership, enforcement or licensing of a (potential) SEP.[60] Such assurance, provided in good faith, is irrevocable and applies, at minimum, from the date of standard's approval by the SASB. Like in case with many other SSOs, there are no mechanisms to force the SEP-holders for disclosure and submission of the LoAs; the refusal to issue licenses according to the patent policy is typically followed by the dialogue between the patent-owner and the Working Group chair/members, intending to reveal the reasons behind the SEP-holder's behavior. The absence of the LoA is considered during the standard's approval process.

In principle, the Working Groups are allowed to decide by which procedures to operate, as long as they respect the requirements of due process and openness and do not contradict the

[53] *Ibid above n 39*, 7
[54] See the definitions of the individual and entity –methods in the previous section
[55] However, the IEEE-SA members are permitted to vote on unlimited number of the IEEE draft standards, see Article 6.3.1 IEEE Standards Association Operations Manual
[56] Article 5.2.1.3.1 IEEE-SA Standards Board Bylaws
[57] See 'The Standards Development Life Cycle' http://standards.ieee.org/develop/index.html accessed on 20 February 2016
[58] For instance, the website of the IEEE 802 .11 Wireless Local Area Networks Group http://www.ieee802.org/11/ accessed 7 March 2016
[59] See http://grouper.ieee.org/groups/pp-dialog/drafts_comments/Patent_Policy_FAQ_031214_redline.pdf accessed on 18 February 2016
[60] See Section 6 of the IEEE-SA Bylaws

IEEE-SA legislation.[61] The Policies and Procedures (P&P) of all Working Group should be approved by their Sponsor, which however can opt for establishing a single procedure for the Working Groups that it manages. Since the most vital decisions, including the incorporation of (essential) technology are likely to be taken during the Working Group's meetings, this standard-setting phase is allied with conflicts of interests and possible strategic conduct of actors. As both mentioned could impede the outcome of standardization, it is crucial to balance, or, where possible, prevent the arising conflict situations. This duty is assigned to the Chairperson[62], who is appointed by the Sponsor or selected by the Working Group at issue. He or she guides the technical process by facilitating the discussions between the participants, and acts as a contact person for technical questions.[63] The contentious Working Group issues are resolved by consensus, meaning that the majority should be in favor of a certain decision. Remarkably, the definition of majority is left to the Working Group concerned: for instance, the quorums for approving the draft standards can be found in the P&P established by the Working Group concerned or by its Sponsor. In fact, each Working Group forms its own 'ecosystem' as a consequence of the high degree of liberty to decide on the procedures by which they are governed, but also due to the hierarchy of officers facilitation the technical activities: apart from the Chairman, the Working Group may also select its own vice chairman, secretary and treasurer.

3.3 Third stage: approval of standard

Once the participants reach consensus, *and* the Sponsor declares that the draft standard is sufficiently mature and stable, the project moves to the Sponsor balloting process. At this step, the Sponsor forms a new individual or entity-based balloting group, whose composition cannot be changed after the voting has started.[64] Although anyone can contribute comments to the draft standard, an IEEE-SA membership or a payment of a per-ballot fee is required in order to be eligible for balloting. However, a prior engagement in the Working Group is neither necessary nor sufficient to guarantee participation in this phase.[65] The procedures seek to maintain balance by appointing balloters from different interest categories (e.g., manufacturers, users, academic, government, or general interest)[66] and precluding any particular category from forming over one third of the group.

The balloting processes take place according 'one member – one vote' principle: each voter can submit the comments while approving or disapproving a draft, or abstain from voting at all. Every negative vote should be supported by specific reasons.[67] Importantly, no companies or individuals may dominate in the process, and no interest category can comprised over one-third of the balloting group.[68] In order for a draft standard to pass this phase, the balloting should result in *consensus*, meaning that 75% of the group has to vote and the 75% of those votes are in favor of the draft, *and* that all technical or editorial comments submitted with the votes are responded.[69] If applicable, a draft can be modified according to the voters'

[61] *Above n 39*
[62] In case the standard is developed by virtue of individual-method, the Chair and Vice-Chair persons should be affiliated with both IEEE and the IEEE-SA
[63] The Standards Development Lifecycle, 'Managing the Working Group' https://standards.ieee.org/develop/managewg.html accessed on 8 March 2016
[64] See 5.4 IEEE-SA Standards Board Operations Manual
[65] 5.4.1 IEEE-SA Standards Board Operations Manual. The reason behind it might be the Institute's goal of reaching the greatest consensus while balancing the representation of all interested stakeholders and avoiding their possible overwhelming influence.
[66] *Ibid*
[67] *Ibid,* 5.4.3.2
[68] *Ibid above n 61*
[69] 5.4.3.3 and 5.4.3.5 IEEE-SA Standards Board Operations Manual

comments, what might subsequently turn negative votes into positive. The ballot fails if 30% of the balloting group members abstain.

Together with the initiation of the consensus ballot, a draft standard opens for the 60-days IEEE-SA Public Review Process, offering interested parties an opportunity to comment on the draft, and the Working Group to respond to those comments.[70] Participation in this process is rather lenient: any person can purchase a ballot draft and submit the comments online via the IEEE-SA website, after paying the individual balloting fee. Even though this part of the approval processes does not contribute to the consensus, it nevertheless allows, to certain extend and against a certain prize, for contributions of those potentially affected by the future standard.

Upon achieving *consensus* in Sponsor balloting, the project is transferred to the IEEE-SASB for its final approval[71]. The SASB reviews the document and supporting material and establishes whether the final draft still falls under the scope of the PAR. The ultimate decision of the SASB regarding the standard's approval is based on the recommendations of the RevCom, which examines whether the relevant procedural principles were respected throughout the processes of standard's formulation. [72]

All actions and decision taken during the approval processes can be appealed by anyone and in any time. Depending on the stage of approval, complains are handled either by the Sponsor, or by the IEEE-SA Standards Board. The exception are the technical appeals, which are always reviewed by the Sponsor. The appeals committee should be comprised of members who were not actively involved in the standard's development. [73]

4 The process leading to the Policy Update

Inspired by the Six Proposals Speech of then US Deputy Assistant Attorney General (now acting Attorney General) for Antitrust Renata Hesse[74], the PatCom appointed the *Ad Hoc* committee in its meeting in March 2013 to discuss possible amendments of its Patent Policy.[75] This committee consisted of the 2013 PatCom members, a 2014-2015 PatCom non-voting member, one IEEE staff member and two non-voting members of the 2016 BOG (the secretary and the administrator)[76]. In the following two years, the members of the Ad Hoc committee joined forces to develop the Policy Update. The Policy was drafted by a subcommittee of the *Ad Hoc* within 15 months following the meeting of March 2013. Since neither the minutes the *Ad Hoc* committee's meetings, nor those of the subcommittee are publically available, the course of the discussions and the rationale behind the decisions taken at those meetings remain unknown. The *Ad Hoc* committee, however, was convinced that this accountability gap was filled in the occasions where its reports were presented, namely the PatCom meetings and the IEEE-SA Patent Forum[77].

After the *Ad Hoc's* approval, the draft was opened for an online public review and commenting. In total, four drafts were available for the public review, 680 comments were

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[70] *Ibid* 5.4.5
[71] Ibid 4.5.2.4
[72] See http://standards.ieee.org/develop/finalapp.html accessed on 29 October 2015, and Article 4.2.3 IEEE-SA Standards Board Operations Manual
[73] *Ibid* 5.8
[74] 'Six "Small" Proposals for the SSOs before Lunch', remarks as prepared for the ITU-T Patent Roundtable by Renata Hesse, Deputy Assistant Attorney General, Antitrust Division of the US Department of Justice. Available at https://www.justice.gov/atr/speech/six-small-proposals-ssos-lunch
[75] See the PatCom Meeting Minutes of 4 March 2013
[76] The IEEE Request for Business Review Letter states that one of them has also been a member of the 2013 ProCom
[77] *Above n 7, 13-15*

made and 547 of them were responded by the *Ad Hoc*. The forth and the last version was approved by the PatCom in June 2014 in the process of simple majority voting, whereby 3 members, which also happen to be the members of the *Ad Hoc* committee[78], including its Chair, voted in favor of the revised policy. The negative votes came from the two members who were not part of the committee.[79] The Chair[80], who was also the member of the *Ad Hoc,* abstained. The draft was subsequently moved for consideration of the SASB, which discussed the proposed policy Update in its open session held in August 2014. After accepting the PatCom report in secret balloting[81], the draft was forwarded to the BOG for its final approval, which took place in December 2014.

At this point it is important to note that, being an ANSI-accredited standards developer (ASD), the IEEE must ensure that standards development procedures of the IEEE-SA meet the ANSI requirements for openness and due process, and represent the *consensus* (emphasis added) of materially affected and interested stakeholders. By the same token, ANSI's acceptance of the TBT Code of Good Practice makes the WTO norms applicable to the ANSI-accredited organizations,[82] requiring the adherence of IEEE standardization processes to the principles of transparency, openness, impartiality and consensus.[83] Although the ANSI and WTO principles initially seem to concern only standards development, they should apply to the same extent to the processes of establishing *policies* governing the development of standards, which are inseparable from organization's standard-setting activities.[84]

Moreover, the IEEE- SA IP Policy is presumed to comply with the patent policy of the ANSI and should reach the objective of providing a *balanced representation* among the rights of interested parties, while avoiding unnecessary restrictions that discourage participation in standard development.[85] It is yet the question if a rather closed 'ecosystem' of the IEEE-SA could adequately balance the rights of various stakeholders. As it appears from the composition of the *Ad Hoc* and the 2014 PatCom, charged with the crucial decision of accepting the Update, the revised Policy was not drafted by all interested stakeholders: rather, the process was greatly dominated by the major technology users, who systematically advocated their commercial tendency in favor of certain policy changes.[86] It is also striking that the technology owners, who should have been represented in the *Ad Hoc* as a counterweight to the technology manufacturers and sellers, were involved in the process only at its final stages. Their negative votes during the PatCom ballot in June 2014 could not possibly make a difference for the outcome, as, in fact, the IP Policy was approved by the three other voters who were the members of the *Ad Hoc* itself. In other words, by entrusting a rather unilateral group with setting the policy governing the activities of *all* stakeholders engaged in the IEEE standardization, and subsequently allowing that group to approve 'its

[78] Those were the representatives of Microsoft, Intel and Apple, see the minutes of the IEEE-SA SASB PatCom meeting of 10 June 2014

[79] Alcatel and Ericsson

[80] Hewlett Packard

[81] The SASB approved the revised Policy with 14 votes in favor and 5 votes against

[82] Annex 3 TBT Agreement, Code of Good Practice for the Preparation, Adoption and Application of Standards; pursuant Article 4.2 TBT, standard-setting procedures of organization that accepted the code are presumed to comply with the TBT Agreement, and thus standards generated by those organizations are presumed not to constitute barriers to trade. See also the List of Standardizing Bodies that have accepted the Code of Good Practice since 1 January 1995, G/TBT/CS/2/Rev.22 (last updated 29 February 2016)

[83] See TBT Committee Decision on Principles for the Development of International Standards, Guides and Recommendations with relation to Articles 2,5 and Annex 3 of the Agreement, Annex 4 of the Second Triennial Review of the Operation and Implementations of the Agreement on Technical Barriers to Trade, 2000, G/TBT/9

[84] It should be noted that the opposite suggestion of the IEEE-SA BOG and the ANSI, introduced in the appeal proceeding of 22 October 2014 and 25 February 2016 respectively, is at odds with the very concept of consensus-based standardization

[85] See the ANSI Patent Policy and the letter of Mrs Griffin to the Federal Trade Commission of 21 June 2011

[86] Hoffinger. R.E., (2015, March) The 2015 DOJ Business Review Letter: The Triumph of Industrial Policy Preferences over Law and Evidence. *CPI Antitrust Chronicle*, 2, 6-7

own work', the PatCom made a large step away from issuing a policy which would reflect a *consensus* of all interested parties.

The challenges around the compositions of decision-making bodies do not solely occur in the PatCom and its *Ad Hoc* Committee. In this regard, it is remarkable that the PatCom members are also the members of the BOG/SASB, the highest rank IEEE-SA organs charged with the ultimate approval of the policy changes. Besides, the SASB's approval of draft Policy is inconsistent with the provisions of the Robert's Rules of Order, requiring a motion for secret balloting.[87] Ultimately, the overall structure and composition of the other SASB committees, apparent from their minutes, attests a restricted environment of the IEEE-SA governance bodies, where members rotate from one unit to another, providing little to non-space for other parties to be actively involved in developing the Standards Association's Policy. Such membership rotation mechanism is problematic given the dual roles of participants: while serving in their individual capacity on the governing board and bearing fiduciary duties to the Institution, members of the SASB and its committees remain the affiliates of companies with strong commercial interests.[88] For this reason, it is of high importance to allow the variety of stakeholders to steer the policies of an SSO, thereby ensuring the balanced representation in its governance.

Hence, the ultimate approval of the Policy Update is not a result of the interested stakeholders acting in symbiosis: not only was it carried out in closed sessions[89], but it was also affected by procedural impropriety and a lack of hierarchical review. Accordingly, the process of the IP Policy Update breaches the core IEEE and ANSI principles of due process and consensus, and by doing so, violates the TBT Agreement of the WTO.

5 Analysis under 101 TFEU

5.1 Applicability of EU Competition Law

The previous section suggests that the IEEE Policy Update was the result of a problematic process, which lacked adherence to the essential procedural safeguards. The absence of *consensus* and balanced participation for all stakeholders not only breaches the core standardization principles, but may also raise antitrust concerns, due to the risk of capture of the policy revision process by a selected majority[90]. In this sense, it can be argued that Policy Update constitutes a decision by an association of undertakings having as effect the prevention, restriction or distortion of competition within the internal market.

Surprisingly, while the risk of anticompetitive concerns arising from biased standard-development was explicitly recognized by the DoJ in reviewing the proposed Policy Update[91], the 2015 Business Review Letter did not inquire whether equivalent safeguards had been respected for the formulation of the policy governing the standard-setting activity.[92] However, it is submitted here that disregarding such fundamental procedural questions is inconsistent

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[87] Robert's Rules of Order, para 30 at 285 (11th ed. 2011)

[88] Biddle, B. e.a.,(2012). The Expanding Role and Importance of Standards in the Information and Communications Technology Industry. *Jurimetrics, 52, pp.177 –pp. 208,* 199

[89] *Above n 84,* 8-9

[90] These concerns were discussed in various occasions during and after the development of the IPR Policy Update; see, for instance, Gregory Sidak's letter to Mrs Hesse of 28 January 2015, but also the comments made in the PatCom public review processes; the Policy Update was appealed twice before the BOG and the ANSI ExSC

[91] See the letter of Mrs Hesse of 2 February 2015, *'...if a standard-setting process is biased in favor of one set of interests, there is a danger of anticompetitive effects and antitrust liability',* p.7, with reference to *Allied Tube & Conduit Corp. v Indian Head Inc* 486 U.S. 492, 511

[92] Sidak,G. (2015). The Antitrust Division's Devaluation of Standard-Essential Patents. *The Georgetown Law Journal Online*, 104(48), pp. 48-pp. 73, 64

with the crucial role that IP policy plays in attracting SSO members and producing the outcomes of standard-setting activity. Since the policy applies to all members and should be followed throughout all standard-setting activity, balance and participation are particularly essential to ensure the alignment of such wide-ranging rules not only with the interest of SSO members, but for the public interest more generally.

Article 101(1) of the Functioning Treaty of the EU (TFEU) prohibits agreements between undertakings, decisions by associations of undertakings and concerted practices having as their object or effect the prevention, restriction or distortion of competition within the EU internal market, and which have the potential to affect trade between Member States. Given the wide application of the IEEE standards developed through the rules established in the IP Policy, it should not come as surprise that the establishment of global standards may be caught by the jurisdiction of the European Union. Specifically, article 101 (1) can be invoked to curb anticompetitive practices which are predominantly or even exclusively carried out outside the European Union (EU). The applicability of EU competition law to the activities of the IEEE (-SA) is not precluded by the US-incorporation of the Institute.

The European Court of Justice has accepted of the extraterritorial application of EU competition law in numerous occasions. For instance, in the *Dyestuffs*[93] and *Woodpulp*[94] cases, the Court upheld jurisdiction where an agreement or concerted practice had been implemented in the territory of the European Union, in particular through subsidiaries or trading parties operating in the EU. Furthermore, in more recent cases the General Court endorsed a theory of "qualified effects", according to which the Commission's jurisdiction extends to conduct having immediate, substantial and foreseeable effects in the European Union[95]. IEEE's standardization activities surely have such effects on competition between EU producers of Wi-Fi – related technology[96], and it can be argued that the implementation of the standards occurs continuously in multiple countries around the world, including the EU, whenever a technology manufacturer produces a unit relying on such standards. Therefore, to the extent that a standard is the result of conduct having anticompetitive object or effect, it is logical to expect that the undertakings involved in the development of the standards will be subject to liability under EU competition law.

5.2 Assessment under Horizontal Cooperation Guidelines

Despite the general prohibition of anti-competitive arrangements in article 101(1) TFEU, the EU legislator allows certain agreements to either be exempted from this provision in light of their likely pro-competitive effects, or to fall outside of its scope altogether due to their inability to restrict competition. The European Commission has facilitated these determinations with the formulation of specific guidelines, which seek to clarify the interpretation of article 101 with regard to a number of typified practices. The Guidelines of relevance for the assessment of the Policy Update are the Horizontal Cooperation Guidelines.[97] The Horizontal Cooperation Guidelines apply to agreements between actual or potential competitors to engage in R&D, production, purchasing, commercialization or standardization. The last category in particular may be applicable to the Policy Update.

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93 Case 48/69, *Imperial Chemical Industries Ltd. v Commission* [1972] ECR 619

94 Joined Cases 89/85, 104/85, 114/85, 116/85, 117/85 and 125/85 to 129/*85 hlström and Others v Commission* [1988] ECR 5193

95 Case T-102/96 , *Gencor v Commission* [1999] ECR II- 753; T-286/09. *Intel Corp. v Commission* (12 June 2014, not yet published and currently on appeal to the European Court of Justice).

96 Many enterprises represented within the IEEE-SA standard-setting forum are global companies either incorporated or having branches in the EU countries

97 Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements (2011/C 11/01), further referred to as 'guidelines'

Standardization agreements have as their primary objective the definition of technical or quality requirements with which current or future products, production processes, services or methods may comply[98]. While an SSO's Patent Policy does not directly define those requirements, its instrumental role in attracting technology developers and manufactures makes it an indispensible pre-condition to standardization in patent-intensive sectors. At the same time, the level of detail and the restrictions required to attract patent owners and standard implementers will depend on the sector in question.

Pursuant to the Guidelines, standardization agreements are not caught by article 101(1) as long as they comply with a set of 4 cumulative requirements. Condition (1) of this *safe harbor* is unrestricted participation in standard-setting[99], including impartial and non-discriminatory balloting procedures and objective criteria for selecting technology to be included in the standard. This requirement is fulfilled in the IEEE-SA's standard-setting procedures, which allow every party (irrespectively of its affiliation and legal personality) to join stages 1 and 2. The equality guaranteed in the approving procedures of the standard developing balloting groups is ensured by the limited quorum for the interest categories, and the IEEE-SA standard-setting stages are marked by numerous occasions to for approaching and inviting potentially interested stakeholders, such as calls for participation in both Study and Working Groups.

This is in stark contrast with the process followed for the 2015 Policy Update: in essence, the Policy was drafted by a close group of private stakeholders affiliated with companies of certain commercial interests. Additionally, the approval by the PatCom, which at the same time lead to the decision to transfer the revised draft Policy for the SASB consideration, was carried out following an improper voting procedure, since a three-to-two vote described in section 2 does not reflect a *consensus,* as required for the development of the IEEE standard documents.[100] Similarly, a 'substantial agreement among directly and materially affected interest categories' could have never been achieved in an unbalanced balloting group, which the PatCom 2014 appeared to be from its meetings.

It should also be noted that no call for participation was issued prior to the establishing of the *Ad Hoc*, keeping the concerned parties uninformed and limiting their statutory rights. Finally, the criteria for the selection of members engaged in the drafting and approving processes of the 2013, 2014 and 2015 PatCom, the *Ad Hoc* and its subcommittee are conspicuously missing from public documents.[101]

Where the criterion of unrestricted participation cannot be fully met, the negative effects derived from this failure can be balanced by informing and consulting interested parties on the drafting processes[102]. In this regard, condition (2) of the *safe harbor* requires procedures for adopting the standard in question to be transparent and the processes leading to defining a

[98] Guidelines, para 257

[99] In this regard, see the Commission Decision in 'Ship Classification' case; the horizontal guidelines update issued in 2011 slightly repeats the statements of the commission with regard to the membership and participation in the technical work. For instance, this decision states that the criteria for the IACS membership should be objective and transparent, the non-members should be allowed to participate in the IACS working groups, the related documents should be publically available and that there is an independent appeal system which reviews the claims with regard to participation in technical process and membership.

[100] Following Article 2.1 of the IEEE-SA Standards Board Bylaws, 'consensus is established when substantial agreement has been reached by directly and materially affected interest categories'. In this regard, 'substantial agreement means much more than a simple majority'.

[101] Those issues have been appealed twice (in August and September 2014) before the BOG. The appeals were filed by the technology-owners disadvantaged by the substantive and procedural aspects of the Policy review (i.e. Nokia, Qualcomm, Ericsson, Alcatel). The first appeal was however was considered not timely, following the denial of the second appeal on grounds that the appellants fail to establish *prima facie* case and that the BOG had no jurisdiction in the matter

[102] Guidelines para 295

standard to take into account the interests of all stakeholders in question. The standards development processes of the IEEE-SA seem to fulfill those criteria by, *inter alia,* prior announcing of the future meeting venues and allowing an unrestricted number of participants to take part in the Working Group's activities. The facts that the meetings of the *Ad Hoc* took place in a private setting, and that the minutes of its subcommittee were never put into public domain, suggest a more closed ecosystem, incompatible with the notions of unrestricted participation *and* transparency put forward in the guidelines.

It is worth noting that, next to maintaining sufficient level of transparency and allowing unrestricted participation of interested stakeholders, standardization work should typically reflect a substantial agreement reached by directly and materially affected interest groups[103]. Such consensus, although defined differently at each stage of standard-setting, always implies a throughout consideration and resolution of all diverging views and objections. As suggested earlier in this paper, the IP Policy modifications did not reflect a consensus of all stakeholders affected by it due to the composition of the drafting and balloting groups and the ambiguous voting process. The justification that, in the given case, the application of consensus requirement would prevent the IEEE-SA to act in the interests of the Institution[104] is at odds with the main governance principles of the IEEE.[105] Besides, since the Institute recurrently stresses the importance of impartiality and fairness in its standard development[106], the failure to accommodate all stakeholders' interests during modifications of the IP Policy would subsequently affect the IEEE standardization activities.

Condition (3) of the safe-harbor relates to the voluntary character of the standards, which is not at issue in this particular analysis – since the use of the standards developed through IEEE remains a free choice of standards implementers.

Condition (4) of the safe harbor refers to access to the standard on FRAND terms. This aspect is obviously a crucial focus of the Policy Update, which ensures access to FRAND-committed SEPs by depriving SEP owners of the ability to seek an injunction, and sets out a methodological basis for the calculation of FRAND. The relevant question is whether these changes contribute to making the resulting Policy clear *and* balanced, adapted to the needs of the industry and the IEEE. While the concerns behind the Policy Update were dictated by the concerns of uncertainty and rising litigation in the sector (ICT) most affected by IEEE standards, no evidence of a pathological situation warranting such drastic changes to its existing IP policy was provided by the IEEE at the initial stage of policy revision. For this reason, and directly consequent to the procedural shortcomings of the process leading to the Policy Update, a serious doubt can be casted on the balance achieved by the updated Patent Policy.

In conclusion, the Policy Update appears to preclude the applicability of the safe harbor to any standardization agreement resulting from the implementation of that policy. This finding has important implications, for it would require the analysis of the substance of each standardization agreement, thereby reducing legal certainty and potentially deterring beneficial standard-setting activity.

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[103] *Above n 54*

[104] See the comments on http://grouper.ieee.org/groups/pp-dialog/bylaws_process.html accessed 15 April 2016

[105] Note that the principle of consensus is managed throughout the IEEE –SA regulatory framework, the Standards Development Lifecycle and the correspondence between the IEEE and the DoJ.

[106] *Above n 39*

6 Conclusion

In this paper, we examine both the procedures leading to the adoption of new IEEE standards and the procedure that were followed during the recent IEEE IP Policy revision. Above all, the latter is demonstrated to be incompatible with the procedural principles of the IEEE, but also with those of ANSI and the TBT Agreement of the WTO. All three regulatory frameworks mention consensus, openness and due process as the guiding principles for standards development. It is the believe of the authors that, while being an essential part of any standardization activities, the IP Policies of SSOs ought to comply with those principles in no lesser extent than the standard-setting procedures.

While enjoying a wide - reaching industry application, the IEEE standards can reasonably be expected to reach within the EU borders, both pursuant to an "effect" and an "implementation" theory. Therefore, standardization activities of the IEEE should be initially scrutinized with regard to their adherence to the EC Guidelines on Horizontal Cooperation. Such analysis suggests that the Institute's standards development maintains a high level of compliance with the document at issue: it includes a wide range of participants in the technical drafting and balloting processes and follows transparent procedures, representing overall a consensus-based standards development activity. On the contrary, the process of the IP Policy Update is unlikely to pass the test introduced in the Guidelines due to its general failure to represent the view of all affected stakeholders, and its disregard of the transparency and consensus requirements. This opens the possibility for undertakings adversely affected by the standard-setting of the IEEE-SA to use competition law in order to invalidate an adopted standard, and impose liability on the IEEE-SA members involved in its development.

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Motives and Barriers of Employees' Participating in Company and External Standardisation Activities

Luisa K. Lazina

Berlin University of Technology, Germany

Luisa.Kim.Lazina@volkswagen.de

Abstract: *This paper examines the motives and barriers of employees' participation in company and external standardisation activities and the interrelation of the activities. It aims to understand the behaviour of employees and gives a theoretical foundation on strategic aspects along the supply chain. The data generated at a German original equipment manufacturer. Surveyed employees were active in either one of the following activities: company standardisation (internal standardisation), external standardisation, patenting or publication. The paper will give first insights into the strategic motives and barriers of external standardisation in officially-accredited formal standard development organisations or in-formal consortia and company standardisation activities. Applying exploratory factor analysis, it was possible to identify relevant factors for company and external standardisation as well as the strategic barriers and motives for employees. In the factor analysis are included eight dummy variables indicating the following employee characteristics: writing company standards, responsible for company standards, participation in external standard development organisations/consortia, patenting, publishing, leadership position, tenure and qualifications of the employees.*

Keywords: *automotive industry, automotive management, company standards, external standards, knowledge transfer, standardisation strategy, standardisation management.*

1 Introduction

In the literature, motives and barriers in company standardisation at employee level and the interrelation of company standardisation and (in)formal standardisation are under-researched topics. In particular, company standardisation is not individually considered and not included in previous analysis. The research gap on company standardisation has been criticised (Riillo, Cesare A. F., 2013b). This paper gives first insights into motives and barriers of employees for company standardisation and the connection between (in)formal standardisation motives and barriers and their relationship to patenting and publishing activities.

Company standardisation and formal standardisation activities combined are important drivers of innovation in companies. Motives for company standardisations are e.g. 'internal optimisation and learning', 'variety reduction', 'first mover advantages' and 'differentiation on the market' (Großmann, Gruben, & Lazina, 2016). Standard essential patents (SEPs) become more and more interesting for OEMs especially in future technologies in the communication field like 5G and LTE for future vehicles due to rising costs through licensing. Advantages for the companies for getting involved in the standard setting organisation (SSOs) is to enable companies to be able to influence SEPs and bring their own patents and therefore set their own SEPs. A further advantage would be to have the possibility to cross license their patents and therefore save costs. As (Isaak, 2006) mentioned, intellectual property is a *dominant factor in today's standardisation*.

Through the participating in the company and external standardisation companies gain a stronger market position and reduced costs. Companies should support the involvement of employees in such activities to gain knowledge and experience in the standardisation process.

Personal characteristics like recognition can be drivers for employees being active in the standardisation activities. In this paper focuses on the employees, mainly developers, because the main activities in standardisation, patenting and publication has been done by developers (almost 60% of the responded questionnaires from eight different business areas were from the development business areas).

Although German original equipment manufacturers (OEMs) are involved in standardisation activities, the activities are often not linked to their company strategies (Grossmann, Filipovic & Lazina, 2015). The considered company in this paper is an OEM and a leading automotive company. The aim of the company is to use technologies and innovations for high quality and new products. For standardisation activities employees are manly self-responsible and standardisation is a management decision. Due to this reason the employees were asked for their motives and barriers in standardisation, taking into consideration their positions, qualifications and tenure in the company. The employees were experts in their field and thus in their respective activity, as company or external standardisation.

The paper is structured as follows. The next section gives an overview of the literature, followed by the motives and barriers of the employees in the third section. Section four describes the data, methodology and results of every exploratory factor analysis. The comparison of the different factor analysis to the motives and barriers of company standardisation and of external standardisation is shown in a Pearson correlation with the independent variables in section five. In the last chapter the results are summarised.

2 Literature Review

2.1 Company Standards and Motives on Company Standardisation

> *Company standards are documents with generally basic content, wide application and repeated use to set rules or characteristics for objects and operations. These are established by consensus within the company and accepted by applying or competent actors that provide, for common and repeated use, rules, guidelines or characteristic for activities or their results, aimed to maximum benefit for the company* (Großmann et al., 2016)

In the above definition the actors of the standard development are the employees of the departments of a company and supplier companies. The minor aim of company standards (CS) is to influence internal activities (Großmann et al., 2016), this is why they are also called internal standards.

Großmann (2013) show by an exploratory factor analysis the motives of the suppliers for applying CS and identified five factors: ‘knowledge transfer, efficiency and security’, ‘Fulfil supplier quality and reputation’, ‘Insufficiency of ES’, ‘Access to buyer’ and ‘Alternative to ES’. Großmann (2013) identified that CS as an alternative to external standards (ES) are of lower importance whereas the quality motives are ranked highly.

2.2 Formal and Informal Standardisation and Motives to Participate in Formal Standardisation

> *[Formal standards are] document[s], established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. […]*(DIN EN 45020)

The formal standards are devolved, in SSOs with actors open to interested group of multiple organisations, the actors are the participants in the SSOs and can either try to prevent standards or constants, introduce new contents or listen and gain knowledge (Jänchen, 2008). The difference from informal standards to formal standards is that the informal standards are not developed in a SSO but by a consortia, an association of different companies or organisations. Informal and formal standardisation is summarised as external standardisation.

Blind & Mangelsdorf (2016) applied exploratory factor analysis and identified five factors of motives for formal standardisation on firm level: knowledge seeking, market access, technical solution, regulation and company interests. Riillo, Cesare A. F. (2013a) interviewed experts from Luxembourg for their motivations in participating in formal standardisation activities. The motivations for the experts to participate in formal standardisation are the sharing of technical knowledge, acquiring of strategic knowledge and recognition.

2.3 Interrelation of company standardisation, (in)formal standardisation

While CS are developed in the company, the formal standards are developed by an external standardisation committee, like SSOs with actors of multiple organisations. CS are used in the company or with cooperating companies, such as suppliers. Therefore they are a private good, only usable for the involved actors like company and partners and can lead to monopolistically situation by the CS (Großmann et al., 2016). Formal standards are developed in open committees, where companies can take part. Formal standards a public good and are usable for everyone and therefore have the market form of perfect competition (Großmann et al., 2016). Informal standards are developed in a selected circle in consortia and are club good, only usable for a selected circle until the maybe brought into a formal standard.

Further, company standardisation is the positioning towards external standardisation (Slob & De Vries, 2002). Großmann et al. (2016) show that different interest and the interrelation between company and external standardisation exist in different ways. Through participation in external standardisation activities, companies have the chance to bring contents of the CS into the development of externals standards (see Johansson, Foukaki, & Kärreman, 2016, Großmann et al., 2016), for example to exploit first mover advantages or to push the own innovation into the market to win standard wars, competing standards (example: HD DVD vs. Blu-ray), and expand market share (Großmann et al., 2016). Companies, in addition, can use an external standard as a base for their own standard but outperform it for example through better quality.

2.4 Interrelation of standardisation, patenting and publishing

Landry, Sahi, Amara, & Ouimet (2010) viewed categories of knowledge transfer activities as, (publishing, teaching, informal knowledge transfer, patenting, spin-off information and consulting services). They show that such activities lead to enhanced performance and that the activities can provide synergies for each other. According to these results, there should be an interest for a company to support these activities for the employees.

Zi & Blind (2014) made first investigations of motives of standardisation, patenting and publishing activities in a research institute environment. They showed the relationship of researchers in publishing, patenting and standardisation activities. There is a negative relationship for publishing (high specific reputation) and standardisation activities. There is a large gap between basic research and standardisation activities, probably due to a restricted cost and time budget. Patenting activities and standardisation have a negative relationship, probably due to the fact that patents are intellectual property rights and patents must be declared before publishing and the integration of patents in standardisation processes needs a lot of effort (e.g. completion of contents, licensing conditions) (Zi & Blind, 2014). They find out that researchers with a PhD and some work experience are more involved in standardisation. For this reason the variable of qualification (EDU) was included.

The relationship between ES and patents has been a subject of research (e.g. Blind, Gauch, Goluchowicz & Rauber, 2013, Blind & Thumm, 2004, Blind & Rauber, 2012), but never including CS. Blind & Thumm (2003) reported a strong link between standards and intellectual property rights, and that companies should try to achieve a combination of standards and patents. Blind & Thumm (2003) concluded that *rationales and objectives of patent holders and standards may differ*. Blind & Thumm (2004) show that standardisation and standards play an important role in the innovation process and they find motives and barriers of patenting. Blind, Marquard, & Rauber (2013) display the relevance of strategic publishing in the companies, which is especially done in larger companies. Strategic publishing is an intellectual property-instrument to publish documents of a technology to prevent third parties from making patent declarations and it is not an industry specific method. Strategic publishing is used because it is a flexible, cost-efficient and quick available instrument (Blind et al., 2013). In the OEMs; strategic publishing is used to publish an invention, but not a patent due to costs and time restrictions, but therefore prevent that an another company can make dements on the invention. These arguments show that standardisation, patenting and publishing are important activities and that motives for external standardisation and patenting are similar.

3 Motivations and Barriers of Employees

Before running factor analysis to identify motives and barriers for employees in the next section, the expected motives and barriers for the activities will be shown. Mainly from the literature, it was possible to identify different types of barriers and motives for the activities and divided them into groups. First the strategic company aspects and second the personal motives, whereby these merge into one another, because employees work for the company and are willing to act in the company interest.

3.1 Strategic Company Aspects

3.1.1 Knowledge Transfer

Riillo, Cesare A. F. (2013a) mentioned that the sharing of technical knowledge and the acquiring of strategic knowledge are motives for experts to participate in SSOs.

According to Blind & Mangelsdorf (2016), knowledge acquisition is a motive for external standardisation. Likewise, Narayanan & Chen (2012) found out that company motive to participate in SSOs is knowledge acquisition. Blind (2006) companies can benefit from knowledge spillovers by participating in SSOs. Hawkins (1999) argues that standardisation consortia are used by companies to gain knowledge.

We expect knowledge acquisition to be an important factor for the employees, and not only for knowledge acquisition, but also for search, diffusion, disclosure and confidentiality of knowledge. While the diffusion, seeking and disclosure are more important in external standardisation, it is the confidentiality of the knowledge that plays an important role in company standardisation. Not giving knowledge to competitors it is more important to keep confidential contents of the CS in the company. As well the aspect of knowledge diffusion is important in the contents of CS, by giving the technical knowledge through the content in CS to the suppliers.

3.1.2 Market Access

Another motive to be active in external standardisation is to gain market access (Blind & Mangelsdorf, 2016), because it creates compatibility of products. Company standardisation is not an instrument for market access, but rather to have a competitive advantage and gain a stronger market position (see Großmann et al., 2016, Blind & Mueller, 2015) by a monopoly position. In order to win standards wars, it is better to set the contents in ES to achieve knowledge diffusion and therefore gain market access.

3.1.3 Company Interest

A further motive for the activities, company interest as well as the corporate objective could be important. Blind & Mueller (2015) concludes from the results of the German Standardisation Panel 2015 (DNP, 2015) that CS play an important role in realising internal corporate objectives. For external standardisation activities the strategy of the company is important in that the employees are supposed to avoid contents or to disclose own company contents (Jänchen, 2008). Regarding company standardisation improving quality, product or processes as well as cost reduction can be in the company interest and therefore are the motives for the employees being active in the activities. It also is important to prevent or to anticipate regulation (Blind & Mangelsdorf, 2016). Company interests and specifics to the company have to be respected in the work and activities of the employee.

3.1.4 Technical Solution

Blind & Mangelsdorf (2016) found for external standardisation participation in the technical solution the motive in terms of solving technical problems for company-specifics. In this case the technical solution is meant. The development of standards by external standardisation organisation, for example, is time-consuming and the influence on external standardisation is difficult to evaluate before actually participating in the committee of an SSO or consortium. Company standardisation can be time consuming or hampered by administrative barriers.

3.2 Personal Aspects of the Employee

3.2.1 Recognition and Personal Drivers

An expected important factor for employees is recognition – either financial, personal or in terms of incentives. Recognition can be monetary or a feeling the employee has at the work space, but also of personal interest. Personal reasons are always drivers for the decision to participate in activities or not. After Isaak (2006) participating in SSOs help for networking, trust and reputation. Riillo (2013a) mentioned that through the participation of external standardisation committees the participants can increase the competence and skills, and especially on the international level as a recognised expert. Danish (2010) found significant results with respect to recognition, work motivation and satisfaction at the workplace of employees. The recognition aspect is expected to play a role in the activity of external and company standardisation, but also see the difficulties to receive recognition on the job. For example, the financial incentives for company and external standardisation do not exist, as they do for example in the case of patents.

3.2.2 Alternatives

In an analysis of Großmann (2013) on the motives of the buyer for company standardisation, they found the factor of 'alternatives to external standardisation' Zi & Blind (2014) mentioned that researchers have a *restricted time budget*. The same argument can be used for all other employees in a company. Opportunity costs are important for the company. Within a company, activities, like company standardisation, need a lot of time, not leaving room for other activities like external standardisation or patenting.

Especially in the case of the barriers, alternatives are reasons to decide against an activity. This can be due to technical reasons, but can also be due to company or personal reasons. Alternatives can be other activities like patenting or publishing, but also that the employee is not interested in being active in external standardisation, because other people are active in the committees or they do not see a need for new standards.

4 Methodology and Empirical Results

4.1 Methodology

The exploratory factor analyses is used mainly in social science and is multivariate statistical model to reduce the number of observed variables to factors, which represent the relationships of the high correlated variables in the groups: factors (Backhaus, Erichson, Plinke, & Weiber, 2016). To reduce the number of objects for motives and barriers for participate in the activities, separated factor analyses were run. Before starting the exploratory factor analysis, the motives and barriers for every activity were ranked that were obtained from the employee survey conducted at a German OEM, separately. The participants were asked to rank all motives (if active) and barriers (if not active) on a 5-point Likert scale from 1 (not important) to 5 (very important). Employees active in an activity were not asked for the barriers, because they were already active. This was due to time restrictions to the questionnaire.

By means of an exploratory factor analysis it was possible to limit the reasons pro and contra for the activities. A principal component factor analysis with orthogonal varimax rotation is used. For a description of the characteristics employee variables were included that were received from the survey (CS_01, CS_02, ES_01, PAT, PUB, POS, TEN, EDU). Description of the independent variables for the factor analyses are listed in Table 1.

Table 1: Description and means of the independent model variables.

Model variable	Indicator	Obs	Means	SD
Independent variable				
CS_01	1 if the employee wrote CS for the OEM, 0 otherwise	627	0.37	0.48
CS_02	1 if the employee responsible for CS for the OEM, 0 otherwise	617	0.26	0.44
ES_01	1 if the employee is or was active in SSOs or consortia for the OEM, 0 otherwise	624	0.20	0.40
PAT	1 if the employee wrote patent applications or patents for the OEM, 0 otherwise	635	0.77	0.42
PUB	1 if the employee published scientific or R&D related for the OEM, 0 otherwise	625	0.35	0.48
POS	Between 1 and 4. Rising with the responsibility 1 for trade worker/clerk, 2 for Team leader/employees with management responsibilities, 3 for head of division and 4 for business area manager	588	1.35	0.59
TEN	Between 1 and 4. Rinsing with the tenure of the employees, 1 for under five years, 2 for 5-10 years, 3 for 10-20 years, and 4 for over 20 years	584	3.08	0.68
EDU	Between 1 and 4. Rising with qualification level, 1 for no study, 2 for bachelor, 3 for master graduation, and 4 for PhD	616	3.05	0.88

SD = standard deviation
Obs = Number of observations

For all activities the employees must still be employed at the considered company at the survey date, otherwise they could not be part of the survey.

4.2 The Sample

The questionnaire was send to 26% of the employees in the R&D department compared to total R&D personnel (sum of R&D personnel: 100%), the employees of a German OEM which were active in either one of the activities in September 2015. In our analysis data from a survey among more than 600 employees were used. Figure 1 illustrates the activities of 566 employees who engaged in standardisation, patenting or publishing. Employees who had no answer to at least one activity (11%) will not be displayed in figure. Figure 1 reports the activities of the employees who were active in company and external standardisation, patenting und publishing and participated in the survey. CS_03 are employees devolved the company standard together with the standardisation department, triggered the standard, and gave content introduction. Those employees getting involved and participated in company standardisation and wrote the standard (CS_01) and were responsible for the company standard (CS_02). The employees in ES_01 are employees active in formal standardisation organisations or informal consortia and participated in the name of the OEM. PAT captures employees active in patenting: submitted an invention application or hold patents related to their work at the OEM. The employees of the company were considered active in publications (PUB) if they had published a research or R&D applied publication on behalf of the OEM.

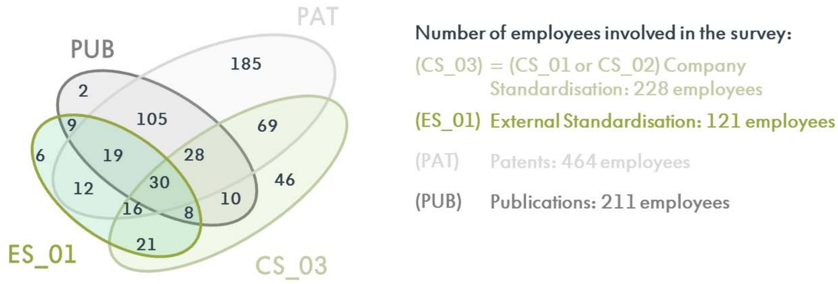

Figure 1: Venn diagram for the 566 employees of an OEM according to their activities.

4.3 Motives and Barriers related to the writing and the responsibilities in Company Standardisation

The questions of motivation for company standardisation were addressed to the employees who wrote and were responsible for CS. They had the possibility to rank 20 motives. All employees not active in company standard got the possibility to rank the nine barriers. In the survey CS were explained as company or group standards that were developed in the group. Correlations between the independent variables are shown Table A7 in the appendix. For all factor analyses we have a Kaiser-Meyer-Olkin measure (KMO between 0.71 and 0.78), provides ‘middling’ results after Kaiser & Rice (1974). In the context of the literature review the resulting factors were discuss and interpreted.

4.3.1 Motives of company standardisation and factor analysis

In Table 2 the motives of being active in company standard activities are displayed. The three highest ranked motivations, higher mean value leads to more important motive, relate to the quality, like ‘Increasing the quality of the final product’, ‘Determining the internal ‘state of the art’’ and ‘Increasing the quality delivered by suppliers (quality assurance)’. The lowest ranked objectives are cost specific, so it can be expected that the employees hope to increase the quality of the products while costs reduction is no major motive for company standardisation.

Table 2: Ranking of company standardisation motives.

Motives for Company Standardisation	Rank	Obs	Mean	SD
Increasing the quality of the final product	1	220	4.48	0.85
Determining the internal ‘state of the art’	2	211	4.47	0.82
Increasing the quality delivered by suppliers (quality assurance)	3	206	4.30	0.96
Efficiency gains through multiple use of CS for various model series	4	201	4.21	0.97
The dissemination of business expertise through CS promotes technical advancement	5	206	3.96	1.06
Workload reduction in the company by repeated applications of the company standard (habituation and learning effects)	6	204	3.95	1.13
The topic does not exist in the ES	7	186	3.78	1.24
Technical scope of ES is too unspecific	8	171	3.78	1.18
Promotion of technical compatibility of components	9	191	3.77	1.16
‘Know-how’ remains within the company (no transfer to an external standard)	10	199	3.72	1.37
The development/establishment of ES takes too long	11	144	3.68	1.28
Efficiency gains through network effects (benefits from sharing experiences increase in the number of users)	12	197	3.64	1.14
Quality of ES does not meet the requirements of the OEM	13	169	3.55	1.23
Higher (legal) security for the constructor	14	179	3.49	1.24
Composition of external standardisation bodies in pursuit of corporate goals is not effective	15	144	3.40	1.26

Competitive advantages through early standardisation of own innovations in CS (if necessary transfer into an external standard at a later date)	16	186	3.31	1.29
Too little influence in external standardisation bodies	17	141	3.25	1.32
Increasing reputation of suppliers	18	182	3.03	1.30
Cost reduction by limiting the range of variations	19	188	3.00	1.33
Costs (e . g. travel costs) for the development/revision of ES are too high	20	134	2.80	1.39

Notes: The mean is the average on a scale of 1 (low importance) to 5 (high importance)
SD = standard deviation
Obs = Number of observations.

By means of an exploratory factor analysis it was possible to identified six factors, shown in Table 3. All factors have an eigenvalue over one. The six factors explain 65 percent of variance.

Table 3: Exploratory factor analysis of motives to participate in company standardisation.

Motives for Company Standardisation	Factor_1	Factor_2	Factor_3	Factor_4	Factor_5	Factor_6
Composition of external standardisation bodies in pursuit of corporate goals is not effective	0.8626					
Costs (e . g. travel costs) for the development/revision of ES are too high	0.8340					
The development/establishment of ES takes too long	0.8313					
Too little influence in external standardisation bodies	0.8204					
The dissemination of business expertise through CS promotes technical advancement		0.7341				
Efficiency gains through network effects (benefits from sharing experiences increase in the number of users)		0.6079				
Workload reduction in the company by repeated applications of the company standard (habituation and learning effects)		0.5365				
Competitive advantages through early standardisation of own innovations in CS (if necessary transfer into an external standard at a later date)		0.6034				
Efficiency gains through multiple use of CS for various model series			0.8555			
Promotion of technical compatibility of components			0.7068			
Cost reduction by limiting the range of variations			0.4793			
Increasing the quality of the final product				0.5929		
Increasing the quality delivered by suppliers (quality assurance)				0.7176		
Increasing reputation of suppliers				0.6531		
The topic does not exist in the ES				-0.4452		
Determining the internal 'state of the art'					0.5077	
Quality of ES does not meet the requirements of the OEM					0.5501	
Technical scope of ES is too unspecific					0.7811	
'Know-how' remains within the company (no transfer to an external standard)						-0.5182
Higher (legal) security for the constructor						0.7943

Notes: Factor analysis method: principal-component factors with orthogonal varimax rotation. Kaiser-Meyer-Olkin measures overall 0.73. Explained variance: 0.65. Loadings between -0.44 and 0.47 are not displayed.

Factor 1 'Insufficiency of External Standards'

The first factor has high factor loadings regarding the following motives: 'The development/establishment of ES takes too long', 'Composition of external standardisation bodies in pursuit of corporate goals is not effective', 'Too little influence in external standardisation bodies' and 'Costs (e. g. travel costs) for the development/revision of ES are too high', all of which are technical problems of the externals standardisation.

Factor 2 'Competitive Advantage through Knowledge'

Factor 2 has high loadings with respect to motives such as 'The dissemination of business expertise through CS promotes technical advancement', 'Workload reduction in the company by repeated applications of the company standard (habituation and learning effects)', 'Efficiency gains through network effects (benefits from sharing experiences increase in the number of users)' and 'Competitive advantages through early standardisation of own innovations in CS (if necessary transfer into an external standard at a later date)'. This factor can be seen as a knowledge defusing aspect which leads to competitive advantages.

Factor 3 'Efficiency, Compatibility and Variant Reduction in the Production'

The factor 3 'Efficiency, Compatibility and variant reduction in the production' has high loadings on: 'Efficiency gains through multiple use of CS for various model series', 'Promotion of technical compatibility of components' and 'Cost reduction by limiting the range of variations'. This factor reflects compatibility of the technical products/components and leads to cost reduction and efficiency.

Factor 4 'Fulfil quality and reputation'

Factor 4 includes technical aspects of the products concerning quality. It has high factor loadings in 'Increasing the quality of the final product', 'Increasing the quality delivered by suppliers (quality assurance)', 'Increasing reputation of suppliers' and a high negative factor loading in 'The topic does not exist in the ES'.

Factor 5 'Technical Contents and gap in ES'

The next factor loads high on 'Determining the internal 'state of the art'', 'Technical scope of ES is too unspecific' and 'Quality of ES does not meet the requirements of the OEM' and therefore is also a quality factor, but more with respect to the contents of the CS and the gap of the contents of ES.

Factor 6 'Company knowledge and security'

The last factor of the motivation to the company standardisation relates the two aspects ''Know-how' remains within the company (no transfer to an external standard)' and 'Higher (legal) security for the constructor (negative)'. While respondents see the advantage of keeping knowledge within the company, they also perceive a gap of knowledge security.

4.3.2 Results of Company Standardisation Motives

In the Table 4 the rank of the six factors by the mean values of the survey data are shown. The 'Technical Content' has the highest mean, followed by the 'Quality' factor. 'Company knowledge' and 'Technical solution' have the lowest values.

Table 4: Ranking of the factors of company standardisation motives.

Motives for Company Standardisation	Indicator	Rank	Obs	Mean	SD
Factor_5 'Technical Content and gap in ES'	Average importance of 'Technical Content and gap in ES'' motives for company standardisation, 1 (low importance) to 5 (high importance)	1	219	4.06	0.83
Factor_4 ' Fulfil quality and reputation '	Average importance of ' Fulfil quality and reputation ' motives for company standardisation, 1 (low importance) to 5 (high importance)	2	222	3.97	0.74
Factor_2 ' Competitive Advantage through Knowledge	Average importance of ' Competitive Advantage through Knowledge ' motives for company standardisation, 1 (low importance) to 5 (high importance)	3	214	3.76	0.87
Factor_3 'Efficiency, Compatibility and Variant Reduction in the Production '	Average importance of 'Efficiency, Compatibility and Variant Reduction in the Production motives for company standardisation, 1 (low importance) to 5 (high importance)	4	214	3.70	0.94
Factor_6 ' Company knowledge and security	Average importance of '*Company knowledge and security* 'motives for company standardisation, 1 (low importance) to 5 (high importance)	5	208	3.65	0.98
Factor_1 'Insufficiency of external Standards'	Average importance of 'Insufficiency of external Standards' motives for company standardisation, 1 (low importance) to 5 (high importance)	6	168	3.38	1.13

4.3.3 Barriers of company standardisation and factor analysis

The nine barriers of the activity in company standardisation were ranked, same procedure as the motives before, see Table 5. The highest and second highest ranks are that there exist already plenty of ES and CS. The third is related to the information asymmetries and not existing connection to the standardisation department.

Table 5: Ranking of company standardisation barriers.

Barriers of Company Standardisation	Rank	Obs	Mean	SD
There are already plenty of ES for my purposes	1	249	3.78	1.01
There are already plenty of CS for my purposes	2	245	3.71	1.04
No personal/organisational bond to the standardisation department	3	226	3.69	1.25
There are already plenty of industry standards for my purposes	4	251	3.65	1.01
Company standardisation process takes too long	5	164	3.45	1.14
Administrative barriers (contact, internal processes, etc.)	6	175	3.39	1.05
Recognition of the standardisation work in the enterprise / from superiors is low	7	179	3.11	1.19
Company standardisation activity is too time-consuming	8	175	3.08	1.19
Knowledge and technology transfer through work standardisation is not suitable for my department	9	234	2.65	1.33

Notes: The mean is the average on a scale of 1 (low importance) to 5 (high importance)
SD = standard deviation
Obs = Number of observations.

The results of the exploratory factor analysis are displayed in Table 6. It was possible to define three factors from the screen plot. All factors have an eigenvalue over one and explain 71 percent of the variance.

Table 6: Exploratory factor analysis of the barriers to participate in company standardisation.

Barriers of Company Standardisation	Factor_1 Company Specifics	Factor_2 Alternatives	Factor_3 Knowledge Asymmetries
There are already plenty of ES for my purposes		0.9200	
There are already plenty of CS for my purposes		0.8287	
There are already plenty of industry standards for my purposes		0.9086	
Recognition of the standardisation work in the enterprise / from superiors is low	0.6494		
Company standardisation process takes too long	0.9030		
Administrative barriers (contact, internal processes, etc.)	0.8558		
Company standardisation activity is too time-consuming	0.7501		
No personal/organisational bond to the standardisation department			0.7523
Knowledge and technology transfer through work standardisation is not suitable for my department			0.8072

Notes: Factor analysis method: principal-component factors with orthogonal varimax rotation. Kaiser-Meyer-Olkin measures overall 0.71. Explaned variance: 0.71 Loadings between -0.3 and 0.3 are not displayed.

Factor 1 'Company Specifics'

Factor 1 has positive factor loadings on 'Company standardisation process takes too long', 'Administrative barriers (contact, internal processes, etc.)', 'Recognition of the standardisation work in the enterprise/from superiors is low' and 'Company standardisation activity is too time-consuming', connecting the technical solution and the recognition aspects.

Factor 2 'Alternatives to CS'

This factor has high factor loadings in 'There are already plenty of ES for my purposes', 'There are already plenty of CS for my purposes' and 'There are already plenty of industry standards for my purposes' and is reflecting the complementary character of the alternatives.

Factor 3 'Knowledge Asymmetries'

The last factor for the barriers of CS relates to 'No personal/organisational bond to the standardisation department' and 'Knowledge and technology transfer through work standardisation is not suitable for my department'. It reflects a missing personal connection to the standardisation department or that there is no need for the company standardisation.

4.3.4 Results of Company Standardisation Barriers

Table 7 shows the ranking of the factors. 'Alternatives to CS' is ranked the highest, 'Knowledge Asymmetries' the lowest.

Table 7: Ranking of the factors of company standardisation barriers.

Barriers of Company Standardisation	Indicator	Rank	Obs	Mean	SD
Factor_2 'Alternatives to CS'	Average importance of 'Alternatives to CS' barriers for company standardisation, of 1 (low importance) to 5 (high importance)	1	272	3.74	0.92
Factor_1 'Company Specifics'	Average importance of 'Company Specifics' barriers for company standardisation, of 1 (low importance) to 5 (high importance)	2	220	3.25	0.95
Factor_3 'Knowledge Asymmetries'	Average importance of 'Knowledge Asymmetries' barriers for company standardisation, of 1 (low importance) to 5 (high importance)	3	265	3.21	1.20

4.3.5 Motives and Barriers related to the participation in External Standardisation

The answers were addressed of the employees regarding the involvement in external standardisation committees on behalf of the OEM.

As explanation in the survey external standardisation as consensus based processes in officially-accredited formal standard development organisations and informal industry standards consortia were defined. If the employees had been active in this kind of external standardisation they were held on to answer the question whether they were or are active in external standardisation activities for the OEM. If the employees had been active in external standardisation, they had the possibility to rank the 19 motives. If they were not active, they could rank the 15 barriers.

4.3.6 Motives of external standardisation and factor analysis

Table 8 shows the ranking results regarding the individual motives for participation in external standardisation. The employees rated strategic motives like 'Help to shape technically mature and industry-oriented standards', 'To use/apply skills (technical, social, political, linguistic, etc.) for the benefit of the company' and 'To avoid standards and contents that contradict the interests of the company' high. Also qualitatively good and safe products are of a high interest as a motive for external standardisation for the employee: 'To continue the state of the art' and 'In order to ensure the safety of equipment and systems'.

Table 8: Ranking of external standardisation motives.

Motives for External Standardisation	Rank	Obs	Mean	SD
Help to shape technically mature and industry-oriented standards	1	120	4.23	0.82
To continue the state of the art	2	121	4.15	0.92
To use/apply skills (technical, social, political, linguistic, etc.) for the benefit of the company	3	121	4.11	0.91
In order to ensure the safety of equipment and systems	4	115	4.03	0.99
To avoid standards and contents that contradict the interests of the company	5	113	3.97	1.15
In order to establish personal contacts and networks	6	119	3.69	1.05
In order to observe the technical knowledge of other competitors or market participants	7	114	3.58	1.14
To address technical problems and to control the development of technology	8	115	3.55	1.12
In order to develop new knowledge within standardisation committees	9	118	3.54	1.03
To promote the international dissemination of the own development and technology through standards (Market Development)	10	110	3.42	1.14
To strengthen certainty about the scope of technological development	11	112	3.41	1.20
In order to prevent market power of de facto standards relevant for competition	12	105	3.41	1.25
To forestall regulation	13	109	3.38	1.25
In order to establish contacts with potential partners (R&D projects)	14	106	3.25	1.17
In order to introduce the results of competitively relevant research into standardisation	15	106	3.23	1.17
To promote interfaces of complementary products from external suppliers	16	97	3.15	1.24
In order to increase own scientific / professional reputation	17	117	2.94	1.37
In order to integrate own property rights on fair terms into standards	18	98	2.50	1.26
Is used as an internal performance indicator	19	109	2.24	1.11

Notes: The mean is the average on a scale of 1 (low importance) to 5 (high importance)
SD = standard deviation
Obs = Number of observations.

Applying exploratory factor analysis it was possible to reduce the number of objects on four factors for the motives of external standardisation. Four factors were determined, because the eigenvalues in the screen plot showed stagnation between factor 4 and 5, although eigenvalues are still larger than one. The four factors are displayed in Table 9. All factors have an eigenvalue over one. The five factors explain 56 percent of the variance.

Table 9: Exploratory factor analysis of motives to participate in external standardisation.

Motives for External Standardisation	Factor_1 Company Interest	Factor_2 Knowledge Seeking	Factor_3 Personal Interest	Factor_4 Market Access
Help to shape technically mature and industry-oriented standards		0.7374		
To continue the state of the art		0.5590		
In order to develop new knowledge within standardisation committees		0.7242		
In order to introduce the results of competitively relevant research into standardisation		0.6188		
In order to observe the technical knowledge of other competitors or market participants	0.7685			
To avoid standards and contents that contradict the interests of the company	0.5563			0.4615
To strengthen certainty about the scope of technological development	0.7294			
In order to prevent market power of de facto standards relevant for competition	0.5854			
In order to establish contacts with potential partners (R&D projects)	0.6793			
In order to integrate own property rights on fair terms into standards	0.6010			
To promote the international dissemination of the own development and technology through standards (Market Development)				0.6771
To forestall regulation				0.7513
In order to ensure the safety of equipment and systems				0.5851
To address technical problems and to control the development of technology				0.5494
To promote interfaces of complementary products from external suppliers			0.4590	
To use/apply skills (technical, social, political, linguistic, etc.) for the benefit of the company		0.5339	0.5830	
In order to establish personal contacts and networks			0.5090	
In order to increase own scientific / professional reputation			0.7449	
Is used as an internal performance indicator			0.6504	

Notes: Factor analysis method: principal-component factors with orthogonal varimax rotation. Kaiser-Meyer-Olkin measures overall 0.76. Explaned variance: 0.56
Loadings between -0.4 and 0.45 are not displayed.

Factor 1 'To use Knowledge for Company Interest'

Factor 1 has high factor loadings regarding the motives: 'To avoid standards and contents that contradict the interests of the company', 'In order to prevent market power of de facto standards relevant for competition', 'To strengthen certainty about the scope of technological development', 'In order to prevent market power of de facto standards relevant for competition', 'In order to establish contacts with potential partners (R&D projects)' and 'In order to integrate own property rights on fair terms into standards'. Factor 1 is interpreted as a factor relating to company interest. Employees either prevent or integrated the willing contents in the standards and also the knowledge seeking and the connection due to the external standardisation meetings is important.

Factor 2 'Knowledge Seeking'

The next factor loads highest the motives 'Help to shape technically mature and industry-oriented standards', 'To continue the state of the art, To use/apply skills (technical, social, political, linguistic, etc.) for the benefit of the company', 'In order to develop new knowledge within standardisation committees' and 'In order to introduce the results of competitively relevant research into standardisation'. This factor differs from factor 1 in that it relates more to knowledge seeking interest regarding the technical aspect.

Factor 3 'Personal Interest, Networks, Interfaces and Reputation'

Factor 3 interprets the personal interests of the employees and loads the motives 'To use/apply skills (technical, social, political, linguistic, etc.) for the benefit of the company', 'In order to establish personal contacts and networks', 'To promote interfaces of complementary products from external suppliers', 'In order to increase own scientific/professional reputation' and 'Is used as an internal performance indicator' high. In this factor we can see the benefits of the employees through external standardisation.

Factor 4 'Safety, Market Access and Regulation'

The last factor of motives for participation in standardisation loads 'In order to ensure the safety of equipment and systems', 'To address technical problems and to control the development of technology' and 'To promote the international dissemination of the own development and technology through standards (market development)' and to 'To forestall regulation' high. This factor not only relates to market access, but also to regulation aspects. Market access and market position can be increased by solving technical problems and improving safety.

4.3.7 Results of External Standardisation Motives

Table 10 shows the ranking of the factors for participation in external standardisation. The most important factors are 'Knowledge Seeking' and 'Saftey, Market Access and Regulation', followed by ''Use of Knowledge for Company Interest' and ''Personal Interest, Networks, Interfaces and Reputation'.

Table 10: Ranking of the factors of external standardisation motives.

Motives for External Standardisation	Indicator	Rank	Obs	Mean	SD
Factor_2 'Knowledge Seeking'	Average importance of 'Knowledge Seeking' motives for external standardisation, of 1 (low importance) to 5 (high importance)	1	123	3.83	0.75
Factor_4 'Safety, Market Access and Regulation'	Average importance of 'Safety, Market Access and Regulation' motives for external standardisation, of 1 (low importance) to 5 (high importance)	2	121	3.60	0.81
Factor_1 'Use of Knowledge for Company Interest'	Average importance of 'Use of Knowledge for Company Interest' motives for external standardisation, of 1 (low importance) to 5 (high importance)	3	119	3.41	0.90
Factor_3 'Personal Interest, Networks, Interfaces and Reputation'	Average importance of 'Personal Interest, Networks, Interfaces and Reputation' motives for external standardisation, of 1 (low importance) to 5 (high importance)	4	123	3.28	0.80

4.3.8 Barriers of external standardisation and factor analysis

Table shows the ranking of the 15 barriers of external standardisation participation. Barriers like alternatives 'Patent protection is preferred over external standardisation' but also aspects of knowledge transfer 'Insufficient information about the work in external standardisation bodies' and 'Knowledge is classified as company internal and therefore not incorporated into standards' are important for the employees (Table 11).

Table 11: Ranking of external standardisation barriers.

Barriers for External Standardisation	Rank	Obs	Mean	SD
Patent protection is preferred over external standardisation,	1	225	3.80	1.09
Insufficient information about the work in external standardisation bodies	2	268	3.74	1.14
Knowledge is classified as company internal and therefore not incorporated into standards	3	244	3.61	1.17
External standardisation process takes too long	4	214	3.57	1.13
Colleagues from Volkswagen are already represented in committees	5	241	3.57	1.05
Standardisation activities in external committees require too much (working) effort	6	220	3.51	1.13
Standardisation activities have minor priority in my OU	7	298	3.49	1.28
Administrative barriers (contact, registration and participation process)	8	209	3.33	1.13
There are already a sufficient number of standards or industry standards for my purposes	9	289	3.27	1.16
Technological knowledge is not sufficiently protected in standards	10	236	3.27	1.21
Too little influence on the standard result	11	215	3.19	1.21
Associations representing the company's interests are already sufficiently represented in relevant committees	12	215	2.99	1.13
Conscious publication of research results is preferably applied	13	182	2.98	1.12
Costs arising from external standardisation work are too high (travel expenses, bodies contributions etc.)	14	202	2.80	1.24
Knowledge and technology transfer through standardisation is not suitable for my department	15	271	2.75	1.30

Notes: The mean is the average on a scale of 1 (low importance) to 5 (high importance)
SD = standard deviation
Obs = Number of observations.

Performing exploratory factor analysis three factors for barriers of external standardisation were found, all are having eigenvalues larger than one. It also would have been possible to consider four factors, but due to the factor loadings the three factors were easier to interpret. The factors are displayed in Table 12. The three factors explain 59 percent of the variance.

Table 12: Exploratory factor analysis of the barriers to participate in external standardisation.

Barriers for External Standardisation	Factor_1 Technical Solution	Factor_2 Knowledge Transfer	Factor_3 Alternatives
External standardisation process takes too long	0.9181		
Standardisation activities in external committees require too much (working) effort	0.8564		
Administrative barriers (contact, registration and participation process)	0.7323		
Costs arising from external standardisation work are too high (travel expenses, bodies contributions etc.)	0.7722		
Insufficient information about the work in external standardisation bodies	0.5320	0.5447	
Too little influence on the standard result	0.5909	0.5188	
Standardisation activities have minor priority in my OU		0.6355	
Knowledge is classified as company internal and therefore not incorporated into standards		0.7068	
Technological knowledge is not sufficiently protected in standards	0.5582	0.5669	
Knowledge and technology transfer through standardisation is not suitable for my department		0.5151	
Patent protection is preferred over external standardisation		0.6082	
Colleagues from Volkswagen are already represented in committees			0.7075
There are already a sufficient number of standards or industry standards for my purposes			0.6369
Associations representing the company's interests are already sufficiently represented in relevant committees			0.8199
Conscious publication of research results is preferably applied			0.4976

Notes: Factor analysis method: principal-component factors with orthogonal varimax rotation. Kaiser-Meyer-Olkin measures overall 0.78. Explaned variance: 0.59
Loadings between -0.4 and 0.49 are not displayed.

Factor 1 'Technical Solution: Time, Costs, Administrative'

The first factor has high loadings with respect to 'External standardisation process takes too long', 'Standardisation activities in external committees require too much (working) effort', 'Administrative barriers (contact, registration and participation process' and 'Costs arising from external standardisation work are too high (travel expenses, bodies contributions etc.)'. The factor therefor is named technical solution: time, cost and administrative. All answers relate to this factor are costs arising through travelling, administrative problems, high work effort and long processes in the external standardisation.

Factor 2 'Knowledge Transfer, not Usable and low Priority'

The next factor 'knowledge transfer, not usable and low priority' loads the barriers of 'Patent protection is preferred over external standardisation', 'Insufficient information about the work in external standardisation bodies', 'Patent protection is preferred over external standardisation', 'Knowledge is classified as company internal and therefore not incorporated into standards', 'Standardisation activities have minor priority in my Organisation Unit (OU)', 'Technological knowledge is not sufficiently protected in standards', 'Too little influence on the standard result', and 'Knowledge and technology transfer through standardisation is not suitable for my department' high. They relate to the knowledge transfer aspect, whether the employees have insufficient information about externals standardisation bodies and they are afraid of defusing (secret) knowledge were they see it as not usable and with low priority.

Factor 3 'Alternatives to ES'

The last factor for the barriers of external standardisation has high factor loadings in 'Colleagues from the OEM are already represented in committees', 'There are already a sufficient number of standards or industry standards for my purposes', 'Associations representing the company's interests are already sufficiently represented in relevant committees' and 'Conscious publication of research results is preferably applied' and shows that the alternatives like sending others, enough standards or publications are preferred over the external standardisation activities.

4.3.9 Results of External Standardisation Barriers

In Table 13 the ranks of the barriers of external standardisation are displayed. 'Knowledge transfer, not usable and low priority' has the highest mean and 'Alternatives to ES' the lowest. We also see an expected 'afraidness' of the employees regarding the fact of giving knowledge outside the company by the participating in external standardisation.

Table 13: Ranking of the factors of external standardisation barriers.

Barriers for External Standardisation	**Indicator**	Rank	Obs	Mean	SD
Factor_2 'Knowledge Transfer, not Usable and low Priority'	Average importance of 'Knowledge Transfer, not Usable and low Priority'' barriers for external standardisation, of 1 (low importance) to 5 (high importance)	1	354	3.48	0.94
Factor_1 'Technical Solution: Time, Costs, Administrative'	Average importance of 'Technical Solution: Time, Costs, Administrative' barriers for external standardisation, of 1 (low importance) to 5 (high importance)	2	255	3.33	1.02
Factor_3 'Alternatives to ES'	Average importance of 'Alternatives to ES' barriers for external standardisation, of 1 (low importance) to 5 (high importance)	3	335	3.28	0.95

5 Results

Figure 2 summarises the factors for the motives and barriers identified in the factor analysis.

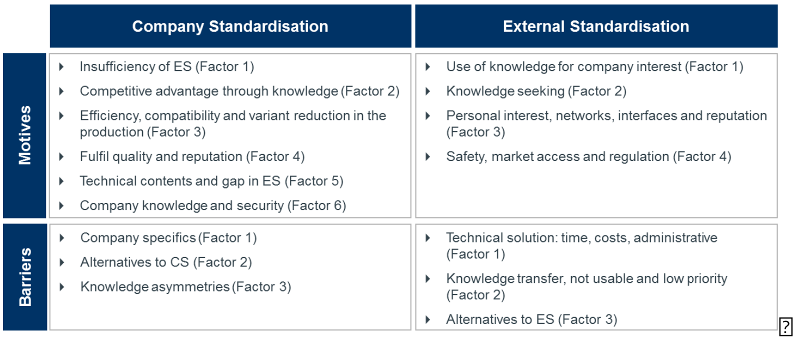

*Figure **2**: Overview Factors of Motives and Barriers for Company and External Standardisation*

A regression of all factors and endogens variables (Table A1) and the correlation (Table A2) are provided in the Appendix. The results can explain the differing degrees of the importance placed on the barriers and motives of the company and external standardisation. The models of 'insufficiency of ES' and 'efficiency, compatibility and variant reduction in the production' for the motives of company standardisation have the best fit, as well as the 'knowledge asymmetries' for the company standard barriers. The best fit for the motives of ES have the models 'safety, market access and regulation' and 'personal interest, networks, interfaces and reputation' and for the barriers 'technical solution: time, costs, administrative' and 'knowledge transfer, not usable and low priority'. In the following the results of the control variables are interpreted.

First, CS_01 ‘employees writing CS’ have a positive significant sign of barriers of the ES in the models of technical solution and the knowledge transfer and have a positive relationship to, while the alternatives in the barriers of external standardisation are negative correlated. There is no influence in the other models. We can confirm that people writing CS have barriers in the technical solution and knowledge transfer of external standardisation, but see less likely alternatives to external standardisation.

Second, employees responsible for CS (CS_02) have a significant positive relation in the motive of company standardisation to the factor insufficiency of ES, the barrier of company standardisation ‘knowledge asymmetries’ it is negative; the other models have no influence. The relationships show that ‘insufficiency of ES’ of the company standardisation has a positive impact on the responsible persons on CS and less barrier of company standardisation in the knowledge asymmetries than persons who are not responsible for CS.

Third, ES_01, the people active in external standardisation are positive in the model of competitive advantages in the company standardisation motives and therefor show that employees active in ES see more a motive the competitive advantages. The regression shows, that ES_01 is negative for the company standardisation motive model of technical solution and the barrier of company standardisation in the knowledge asymmetry model, so the people active see here less likely a motive and barrier.

Fourth, PAT has a significant positive relationship in the motive of company standardisation in the ‘efficiency, compatibility and variant reduction in the production’ and the motives of ES in the models of ‘use of knowledge for company interest’ and ‘personal interest, networks, interfaces and reputation’. This results show employees are active in patenting have motives in company and external standardisation.

Fifth, PUB is not significant over all models.

Sixth, POS is only significant in the ES_01, for the motive of ‘personal interest, networks, interfaces and reputation’ and the barrier of technical solution it has a negative relationship. The motive of external standardisation in the ‘safety, market access and regulation’ is significant positive correlated, people with a higher position see the motive of ‘safety, market access and regulation’, while they see less the personal aspects of the employees and less a barrier in the technical solution of ES.

Seventh, EDU is significant positive correlated the motive of company standardisation in the model of ‘efficiency, compatibility and variant reduction in the production’ and in the barriers of ES in the model of ‘knowledge transfer, not usable and low priority’. The higher the graduation level, the less likely the employees see these motives.

Last, TEN is significant positive correlated in the motive in company standardisation models of ‘insufficiency of ES‘ and ‘company knowledge and security’, as well as in the barriers of company standardisation in the model of ‘alternatives to new CS’. A negative relationship in the model of the motives of external standardisation in the ‘safety, market access and regulation’ is shown.

We confirm that employees with a higher tenure in the company see a motive in the ‘Insufficiency of ES’ and the ‘company knowledge and security’ in the field of company standardisation, whereas they also see alternatives to new CS as a barrier. The higher the tenure the employees have in the company the less the employees see ‘safety, market access and regulation’ as a motive for external standardisation.

6 Concluding Remarks

The study analyses different motives and barriers for company standardisation and external standardisation of over 600 employees working for a German OEM. The paper conducts factors for every activity and the motives and barriers and finally compared the factors according to employee characteristics: writing CS, responsible for CS, activity in external standardisation, publishing, patenting and the leading position, graduation and tenure of the employee.

Different factors were found for the motives and barriers for company and external standardisation. Regarding company standardisation identified motivating factors to be the insufficiency of ES, fulfil quality and reputation, competitive Advantage through knowledge, ‘efficiency, compatibility and variant reduction in the production’, and keeping company knowledge and security in the company. Barriers are alternatives to new CS, company specifics and knowledge asymmetries. Furthermore it was possible to show that employees whom are not active in patenting are less motivated for company standardisation than employees that are active in patenting activities. This can be due to the fact that those people are sensitised for keeping knowledge within the company. However, other factors are loaded higher as well, indicating that those employees see motivation for company standardisation in other factors. The analysis showed that there are a lot of barriers for the employees. Motives for the participation in external standardisation turn out to be the following factors: to use knowledge in the interest of the company, knowledge seeking, personal interest and market access. As barriers the factors of technical solution: time costs, administrative ‘knowledge transfer, not usable and low priority’ and ‘alternatives to ES’ were found, but also showed that there are differences between the groups of employees for the activities. Overall the model of ‘insufficiency of ES’ is much better rated by the people responsible for CS than by employees participate in external standardisation. The position of the employees is only significant in the motives of external standardisation, whereas employees with a higher position see ‘safety, market access and regulation’ as a motive of external standardisation and the ‘personal interest, networks, interfaces and reputation’ of employees less likely. Employees with a higher tenure have a lower rating in the ‘safety, market access and regulation’ than employees with a lower tenure.

Further research should implement strategic aspects for motivating employees for the different activities. Also it should be focused on the interaction between company and external standardisation activities. Furthermore analyses on the interrelation of standardisation, patenting and publishing actives undertaken by the employees and different approach and results if the employees are involved in more than one activity are suggested for a future research.

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Appendix

Table A1: Results of multivariate OLS models.

	Motives of company standardisation						Barrier of company standardisation			Motives of external standardisation				Barriers of external standardisation		
	Factor_1 Insufficiency of ES	**Factor_2** Competitive Advantage through knowledge	**Factor_3** Efficiency, compatibility and variant reduction in the production	**Factor_4** Fulfil quality and reputation	**Factor_5** Technical contents and gap in ES	**Factor_6** Company knowledge and security	**Factor_1** Company specifics	**Factor_2** Alternatives to CS	**Factor_3** Knowledge asymmetries	**Factor_1** Use of knowledge for company interest	**Factor_2** Knowledge Seeking	**Factor_3** Personal interest, networks, interfaces and reputation	**Factor_4** Safety, market access and regulation	**Factor_1** Technical Solution: Time, costs, administrative	**Factor_2** Knowledge transfer, not usable and low priority	**Factor_3** Alternatives to ES
CS_01	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	(dropped)	0.239	0.059	0.107	0.035	0.295*	0.248*	-0.291*
										(0.223)	(0.189)	(0.197)	(0.195)	(0.176)	(0.144)	(0.150)
CS_02	0.348*	0.093	-0.072	0.039	0.165	0.023	0.165	0.096	-0.839**	-0.182	0.272	-0.044	-0.018	0.213	-0.102	-0.084
	(0.205)	(0.141)	(0.150)	(0.117)	(0.127)	(0.163)	(0.309)	(0.290)	(0.373)	(0.218)	(0.184)	(0.192)	(0.190)	(0.193)	(0.166)	(0.173)
ES_01	-0.392**	0.312**	0.149	-0.040	0.090	-0.221	0.275	-0.280	-0.648***							
	(0.189)	(0.140)	(0.150)	(0.118)	(0.128)	(0.165)	(0.205)	(0.181)	(0.240)							
PAT	0.317	0.006	0.253*	-0.031	-0.148	-0.175	0.258	-0.097	0.085	0.436**	0.164	0.361**	0.232	0.239	0.228	0.048
	(0.195)	(0.139)	(0.149)	(0.116)	(0.127)	(0.161)	(0.232)	(0.194)	(0.263)	(0.186)	(0.156)	(0.162)	(0.162)	(0.182)	(0.155)	(0.167)
PUB	-0.120	-0.056	0.044	-0.184	-0.062	-0.175	-0.037	0.072	0.201	0.162	-0.072	-0.118	0.254	0.013	-0.021	0.010
	(0.202)	(0.147)	(0.157)	(0.123)	(0.133)	(0.170)	(0.167)	(0.144)	(0.189)	(0.182)	(0.154)	(0.160)	(0.159)	(0.154)	(0.128)	(0.135)
POS	-0.119	0.018	0.122	0.023	-0.095	0.057	-0.135	-0.022	0.110	0.195	-0.087	-0.229*	0.230*	-0.190*	-0.045	0.015
	(0.160)	(0.113)	(0.122)	(0.093)	(0.101)	(0.130)	(0.126)	(0.110)	(0.142)	(0.147)	(0.124)	(0.129)	(0.128)	(0.113)	(0.095)	(0.099)
EDU	0.220	-0.061	-0.235**	-0.034	-0.069	0.024	-0.042	-0.176	-0.060	-0.062	-0.041	-0.068	-0.040	-0.193	-0.173*	-0.104
	(0.136)	(0.097)	(0.105)	(0.081)	(0.087)	(0.113)	(0.138)	(0.109)	(0.154)	(0.142)	(0.116)	(0.121)	(0.124)	(0.120)	(0.096)	(0.098)
TEN	0.287***	0.118	-0.024	0.053	0.046	0.141*	0.083	0.153**	-0.070	-0.152	0.003	0.067	-0.160*	0.066	-0.034	0.094
	(0.099)	(0.073)	(0.077)	(0.061)	(0.066)	(0.084)	(0.090)	(0.077)	(0.108)	(0.097)	(0.082)	(0.085)	(0.085)	(0.087)	(0.067)	(0.074)
_cons	1.790***	3.369***	4.112***	3.967***	4.274***	3.284***	3.024***	3.925***	3.458***	3.330***	3.851***	3.415***	3.577***	3.631***	3.944***	3.372***
	(0.613)	(0.426)	(0.459)	(0.357)	(0.388)	(0.492)	(0.533)	(0.429)	(0.620)	(0.602)	(0.497)	(0.517)	(0.527)	(0.480)	(0.389)	(0.416)
Obs.	152	193	191	199	198	189	186	226	223	103	104	104	103	218	309	292
Adjusted R2	0.104	0.014	0.021	-0.009	0.012	0.005	-0.013	0.031	0.034	0.051	-0.005	0.026	0.042	0.047	0.007	0.019

*Note: t statistic in brackets. A correlation matrix of the endogenous variables provided in the A2; ** p<0.05, *p<0.10, ***p<0.01*

Table A2: Correlation matrix of the independent variables for motives on company standardisation.

	CS_01	CS_02	ES_01	PAT	PUB	POS	EDU	TEN
CS_01	1							
	(0.0000)							
CS_02	0.6634*	1						
	(0.0000)	(0.0000)						
ES_01	0.2522*	0.1889*	1					
	(0.0000)	(0.0000)	(0.0000)					
PAT	-0.2454*	-0.2994*	-0.1509*	1				
	(0.0000)	(0.0000)	(0.0002)	(0.0000)				
PUB	-0.0247	-0.0776	0.2114*	0.1636*	1			
	(0.5399)	(0.0560)	(0.0000)	(0.0000)	(0.0000)			
POS	0.0613	-0.0425	0.1025*	0.0248	0.2220*	1		
	(0.1409)	(0.3116)	(0.0139)	(0.5488)	(0.0000)	(0.0000)		
EDU	-0.0439	-0.0673	0.0702	0.1353*	0.3791*	0.2031*	1	
	(0.2929)	(0.1095)	(0.0932)	(0.0011)	(0.0000)	(0.0000)	(0.0000)	
TEN	0.0733	0.0291	0.0007	0.0071	-0.0929*	0.1619*	-0.2350*	1
	(0.0712)	(0.4784)	(0.9856)	(0.8601)	(0.0225)	(0.0001)	(0.0000)	(0.0000)

Note: Table displays Pearson correlation coefficient (p<0.05). Significance levels in brackets.*

The Role of Quality Infrastructure for the Wind Energy Sector in Germany

Axel Mangelsdorf and Björn Borchert

Federal Institute for Material Research and Testing and Technical University Berlin
Axel.mangelsdorf@bam.de bjoern.borchert@campus.tu-berlin.de

Abstract: *This explorative paper examines the role of quality infrastructure (QI) for the wind energy sector in Germany. We interviewed different stakeholders groups - from certification and accreditation bodies to insurance providers and wind energy producers - in order to gain an understanding on how different QI components contribute to the collaboration of the different stakeholder groups. We differentiate between mandatory and voluntary measures. Mandatory laws, according to our interviewees, contribute to the stability of power grids or safety of turbines. Voluntary measures are used to promote confidence among different project participants. Voluntary certifications are also signaling instruments, which help suppliers to enter projects. Accredited services are preferred vis-à-vis non-accredited services. Certifications of entire projects are rather used for non-standard large scale offshore projects. Stakeholders of the wind energy sectors are content with the QI in Germany but also suggest improvements, in particular for mutual acceptance of voluntary test procedures and results.*

Key words: *Quality infrastructure, third-party certification, wind energy sector, trust, stakeholder, DAkkS, accreditation*

1 Introduction

Economic history tells us that wind energy has been used for more than 4,000 years. Windmills convert energy into mechanical energy for corn milling or water pumps (Gasch, Twele 2013). Modern wind energy installations convert energy of moving air into electrical power. Modern wind energy became much more complex than its predecessors in terms of technology and also in terms of the number of stakeholders involved in wind energy projects. Modern wind energy turbines also have high quality requirements. Complexity and quality requirements in wind energy projects is managed with the help of a modern quality infrastructure - the system of a standardization, technical regulation, certification and accreditation. Since there is a gap in economic research regarding the role of quality infrastructure for wind energy projects, our paper is a first attempts to understand the role of standards and the like for the functioning of the sector. In order to get a better understanding on the role of quality infrastructure in wind energy, we conducted several interviews with stakeholders in Germany.

In 2015 wind energy accounted for 13.3% of gross electricity generation in Germany (Bundesministerium für Wirtschaft und Energie 2016). More than 25,000 wind turbines provided installed power of more than 40 GW (Deutsche Windguard GmbH 2016). Wind energy is the main renewable source for electricity generation in Germany. In addition, wind energy business is growing worldwide, especially in Asia. China goes ahead by installing new wind energy capacity of approx. 15 GW every year (Schulte 2013).

Modern wind energy turbines must be designed to fulfil demanding quality requirements. During a designed lifetime of 20 years the structures of a wind energy converter must resists more than 10^9 mechanical load changes. In comparison: aircrafts must resist 10^6, bridges

10^7 and helicopters 10^8 load changes (Dr.-Ing. Heilmann 2014). High quality requirement are creating a demand for quality certifications. Is the certification market working well for producers of wind energy turbines? What is the role of accreditation? How do banks and insurance companies evaluate the performance of the quality infrastructure in Germany? We try to answer the questions with the help of expert interviews. We conducted interviews with representatives of the German accreditation body, private certification bodies, manufacturers of wind energy converters, banks and financing companies and project developers.

We structure our paper as follows. We briefly introduce the topic of quality infrastructure and a theoretical background in the second sections. We present the finding of the expert interviews in the third section. We summarize and conclude our research in the last section.

2 Quality infrastructure in Wind Energy

The term quality infrastructure summarizes all measures that are needed to ensure the quality of products and services. This includes metrology, standardization and testing, quality management, conformity assessment, certification and accreditation. Quality infrastructure enables specialized production and facilitates international exchange of products and goods (Hagemann 2015). In economic terms, quality infrastructure contributes to overcome information asymmetries and create confidence between different actors such as manufactures and consumers or project developers and banks and insurance providers. Several quality infrastructure services or components are used in the wind energy sector. We describe common services and (technical) purpose in the following section.

2.1 Type certification or type approval

Type certification is used to confirm that wind energy turbines fulfil requirements regarding the design, production, quality management system and prototype testing. Requirements are set out in the international standard IEC 61400. Design requirements are mandatory requirements in Germany. Amongst others, control and safety concept, load assumptions and structural components have to be assessed. The purpose is to ensure safety and structural reliability. Production related requirements are related to materials used during production and installation. Quality management system means that manufacturers are certified according to the ISO 9001 standard. Testing requirements are related to electrical properties. Testing needs to be carried out by an accredited measurement institute. A type certificate can be issued of all four requirements are fulfilled.

2.2 Project certification

Project certification has a broader focus than type certification. Site design conditions and the suitability of a specific (type of) turbine for a given site will be assessed. Project Certification covers the aspects of assessing site design conditions and suitability of the wind turbine. It also covers the assessment of wiring and transformers, as well as surveillance of production, transport and commissioning of the turbines. Precondition of a project certificate is the type certificate of the chosen turbine. Project certification consists of five modules (which can also be carried out individually) (1) assessment of site design conditions, (2) site-specific design assessment, (3) surveillance during production, (4) surveillance during transport and installation, and (5) surveillance during commissioning. Site design conditions include wind conditions, soil conditions, influence of the wind farm configuration, electrical grid conditions and other environmental conditions. These will be compared to the design parameters of the turbine (type certificate) to check for suitability. (Mike Woebbeking et al. 2012)

2.3 Certification of grid conformity

Another important quality infrastructure service is the certification of grid conformity. Grid conformity ensures the conformity of a generation unit with the grid code. Grid conformity is a mandatory requirement in Germany in order to get access to a power grid. Grid conformity is technically necessary to ensure the stability of an electrical grid. Since the share of electricity generated from renewable sources in German power grids is not negligible anymore, also renewable energies must contribute to the stability of the grid by fulfilling the requirements of the grid codes (MOE 2016). Grid codes regulate for instance the desired behaviour of generation units in case of over-/under-frequency (VDN Verband der Netzbetreiber e.V. 2007).

2.4 Component certification

Individual major components (e.g blade or gearbox) of wind energy turbines can also be subject to certification. These certificates can be used to facilitate type certification of the whole turbine. Component certification attests conformity of documentation, design and manufacturing with design assumptions, standards and technical requirements. Certification scheme of component certification is based on type certification scheme (TÜV Rheinland 2016).

2.5 Other certification services

Interviewees reported that besides presented major quality infrastructure services, others exist. Some certification bodies develop own certification schemes, e.g. certification of services workforce. Besides, other certification services, which have not been specifically developed for the wind energy sector, have a certain relevance, but play a minor role, e.g. certification of fire protection systems.

2.6 Theoretical background

Since the seminal work of Akerlof in 1970 "The market for lemons", "information asymmetry has been acknowledged as being a significant market failure." (Fischer 2014) In the context of food industry, Deaton describes that many quality attributes (of food) are difficult to detect (Deaton 2004). This problem also applies to the wind energy sector. Many quality attributes are not visible at first sight, not even for technically experienced people. Important quality attributes are hidden: responsible design process with safety reserves, choice of materials and manufacturing procedures, suitability of components, etc. In order to assess these attributes, technical expert knowledge and a lot of effort is necessary. In addition, parts of these quality attributes are business secrets, that manufacturers do not want to unveil to a greater audience.

One mechanism, to overcome these information asymmetries, is signaling, which Spence recognized in 1973. Sellers or producers can invest in costly and observable actions to reveal information on unobservable quality. This can be achieved for instance by investing in reputation, spending money on advertising or providing warranties. (Fischer 2014)

In terms of quality infrastructure, another variant of signaling will be addressed: certification by third party.

In his contribution "Standardization in technology-based markets" Tassey emphasizes the infrastructure role of standards (Tassey 2000, p.600). To assess the economic impact of standards, he classifies the basic functions into four categories: 1. Quality/reliability 2. Information standards 3. compatibility/interoperability 4. Variety reduction (Tassey 2000, p. 589f).

In the context of wind energy business, type certification/approval mainly addresses the function of quality/reliability. The function of information standards can mainly be applied in terms of metrology and testing, which is also necessary for type approval/certification. Certification of grid conformity aims at achieving compatibility with the requirements for a stable operation of the specific power grid a turbine will be connected to. Variety reduction is achieved by assigning a wind class to every wind energy turbine.

3 Interview Results

Stakeholders are all internal and external groups of persons that are affected directly or in directly by an entrepreneurial activity currently or in future (Prof. Dr. Thommen, Jean-Paul 2016). For our paper, we identified the following stakeholders: the Germany accreditation body (DAkkS), certification bodies, standardization bodies, manufacturers, suppliers, banks and other financing companies as well as other service providers such as project developers. Figure 1 provides an overview on quality infrastructure and interaction with important stakeholder groups.

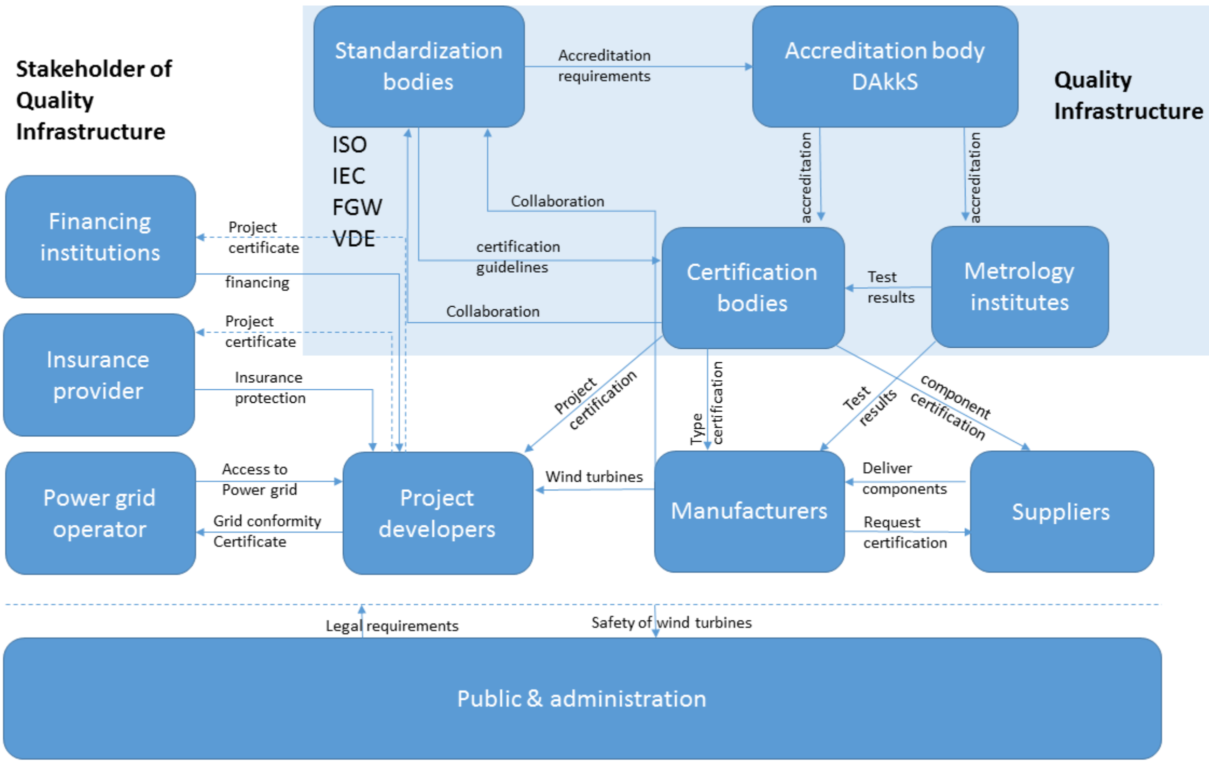

Figure 1 Quality infrastructure of wind energy sector and important stakeholder groups

All in all we conducted more than ten expert interviews among different stakeholder groups in the period from November until December 2015. To gain interview partners, relevant players of the stakeholder groups were contacted via E-Mail. Respondents have been interviewed.

Posed questions concerned the role and use of quality infrastructure, conditions for use of voluntary measures, benefits, possible improvements, problems that occur in daily work, competition, quality of services, harmonization of guidelines and standards and international perspectives of each stakeholder.

In the following paragraphs we summarize the interviews which we conducted by email, phone or personal meetings. Their interest in and their view on quality infrastructure in the wind energy sector will be discussed on the basis of the answers of the expert interviews that have been conducted among these groups.

3.1 Accreditation

The accreditation body (DAkkS – Deutsche Akkreditierungsstelle – Germany accreditation body) is the supervising instance of the quality infrastructure system in Germany. Since January 2010 the DAkkS has been the single accreditation body in Germany. It is organized as a non-profit limited company that conducts official duties and is controlled by the ministry of economics. The mandate of the DAkkS is conducting accreditations of any kind in order to foster trust into conformity assessment bodies. The requirements, which candidates for accreditation must comply with, are stated in DIN EN ISO/IEC 17065. Certification bodies and other conformity assessment bodies must prove to an independent body (the DAkkS), that they are technically competent and that they execute activities with respect to legal and normative requirements. Furthermore, the DAkkS ensures that conformity assessment bodies perform their services (certificates, inspections, testing, calibration) on an internationally comparable level. Issued certificates, inspection and testing reports are being checked on a regular basis. Measuring equipment will be checked for calibration and new staff for appropriate qualification and independence. If there is an indication from the market, the DAkkS also takes actions between regular check-ups. Certification bodies must be reassessed on an annual basis. Testing laboratories (or measuring institutes) are checked every 18 months. If deviations occur, they have to be refitted. The DAkkS classifies deviations as “minor” or “major”. Major deviations must be corrected on a very short notice in order to retain the accreditation. Deviations occur regularly, in most cases minor ones. The accreditation body can never (and does not) guarantee the quality or correctness of an individual certificate or conformity statement. Accreditation is a proof of capability.

3.2 Certification bodies

Certification bodies (or agencies) are companies under private law, which offer different quality infrastructure services. There are about 15 certification bodies operating in the sector of quality infrastructure services for the wind energy sector (EE 2013). In Germany, several certification bodies offer their services, either on the national market or internationally. The size of the companies operating in Germany varies from a couple of dozen employees to more than 200. There are specialized bodies, which offer mainly one service, e.g. grid conformity certification on the national market, since this is only required (by law) in Germany. Bigger companies offer plenty of different quality infrastructure services nationally and internationally. Most certification bodies offer certification services for other renewable energies as well (e.g. solar power). In the case of project certification and type certification, the wind energy sector remains the main target group. Companies that are specialized on grid conformity certification focus on the wind energy sector to a lesser extend because this service is requested for all electricity generating units from renewable sources in Germany and the generation technology plays a minor role when conducting the service (requirements differ, but testing and assessment is very similar).

All interviewed experts of certifications bodies reported that competition hast become more fierce during the last ten years, especially in Germany, but internationally as well. Interestingly, most internationally operating certification bodies are German companies, due to the leading role of Germany in the development and implementation of quality infrastructure in this sector. Because the requirements of certifications services are set by certification guidelines and the scope of the services is fixed, competition is expressed by the price of the service. On the other hand, interviewed experts reported that there is a lower boundary for the price, because certification business requires a lot of man-power and high qualification of the personnel. Additionally, the accreditation body requires that certification bodies make use of a non-public price list for their services in order to avoid discrimination of customers. Therefore, certification bodies can only offer low prices by organizing their work more efficiently. Some experts argued that the market for certifications for wind energy in Germany reach a point where it is not very attractive anymore for new players to enter the market. Accordingly, national players are dominant on the German market. International certification bodies are not expected to enter the German market due to high market entry barriers. Barriers are created through low profit margins due to incumbent German companies and, more importantly, strict requirements for personnel and high costs of accreditation.

Most experts expect that competition will stay on the present high level. Furthermore, future development of the national business is highly dependent on the development and political support of the wind energy sector and of renewable energies in Germany. The current and future challenge for German certification bodies is to enter foreign markets for certification of wind energy services.

All interviewed experts reported that they are involved in the development of standards and guidelines in the area of the services they offer. This applies for instance to the work in the wind energy committee of the IEC (International Electrotechnical Commission) which issues the international guideline for the certification of wind energy converters. An example on the national level is the work in the committees of German Association for Wind Power Promotion and other renewable energies or VDE the society of German electrical engineers.

With regard to the standards and guidelines developed in standards development organizations, the interviewees from the certification bodies explain that there are tensions between guidelines developed at IEC and a guideline developed by a certification body, the DNV GL (former Germanischer Lloyd) (DNV GL 2016). Although IEC and DNV GL started attempts to harmonize the guidelines, competition between different guidelines is generally welcome. Anyway, our interviewees expressed concerns that different requirements, especially national singularities, will increase cost for the wind energy sector.

3.3 Manufacturer of wind energy turbines and service companies

Manufacturers are companies which produce and sell wind energy converters. Some parts of the wind energy converter will be produced by the manufacturers themselves, other parts will be purchased from suppliers. Service companies are companies, which do the technical maintenance of wind energy converters. Service includes for instance regular surveillance of the components, exchange/refill of oil, but can also include the exchange of (broken) parts. Most manufacturers have their own services department and offer (all-inclusive) service contracts for their own turbines. Therefore, these two groups are treated as one stakeholder group since perspectives are quite the same.

Manufacturers of wind energy turbines are directly affected by quality infrastructure because they have to purchase the certification services in order to sell their turbines. Most manufacturing companies sell their turbines worldwide, so certification is an important issue for them even if the regulation in the main market does not require certification. Only regional manufacturers, who sell their products only to countries where certification is not required can neglect the requirements of international certification schemes.

Quality infrastructure affects service companies either directly or indirectly. In most cases they do not buy the quality infrastructure services themselves, except for the case they request certification for their own service force. On the other hand, quality infrastructure affects service companies indirectly, because they have to work with certified wind energy farms (project certification), turbines (type certification or type approval) or components (component certification). Service companies can also be affected by the quality infrastructure in the case of project certification: If service companies maintain wind energy parks, which have a project certification, they must stick to the guidelines and standards if it comes to changes or replacements of parts in order to maintain the validity of the Project Certificate (periodic monitoring required).

Manufacturing companies will get their wind energy turbines and components certified if customers or law requests it. So the driver for certification is a commercial or regulatory perspective. Not every single part of a wind energy converter must be assessed. Subsequently components will only be certified if the guidelines or the certification body stipulate certification. Manufacturers request certification of components from their suppliers to facilitate certification of the whole wind energy converter. Service companies and service departments make rare use of the certification of their service forces because they do not recognize any extra benefit.

According to our interviewees, manufacturers appreciate international harmonization of standards and guidelines. They experience many special national requirements. Although there is no technical challenge to deal with several requirements, differing standards increase costs. Besides differing standards, manufactures are even more concerned with a lack of recognition of testing results both at the national and international level. The lack of acceptance leads to doubling of testing and unnecessary costs for manufacturers.

Manufacturers are customers of the certification bodies. Interviewees from manufacturers agree that, at least at the European market, certification bodies provide high quality services with little quality differences. Quality differences might be discovered in terms of testing, e.g. how data is collected and interpreted. Furthermore, difference exist among certification bodies in terms of responsiveness or organization of processes. Finally, major manufacturers also participate in the development of standards and guidelines. They contribute to work of the IEC and deliver input to the expert commission of GL.

3.4 Banks and insurance companies

The interviewees from banks that finance wind energy projects also make use of quality infrastructure services. Banks make, however, only extensive use of voluntary measures when project deviate from 'normal' conditions. That is, projects with offshoring scope, unexperienced project management teams and the like. In such cases banks face higher risks. Banks require, therefore, quality signalling measures, including project certifications. Banks use the results of project certifications for their financing decisions.

Insurance companies offer, amongst other products for the wind energy business, liability insurances for the operators of wind parks, which protects the operator from damage to persons or property caused by the wind energy turbine (e.g. blade falling down). For that reason, insurance companies have a vital interest in the safety and longevity of the insured turbines. Other insurance products pitch in when operation of the turbine is interrupted due to technical failure. So failure-free operation of the wind energy projects of their customers is also an important issue that can be addressed by quality infrastructure services. Therefore insurance companies make use of certification services in order to assess or minimize the technical risk.

3.5 Project developers

Project developers plan wind energy projects and are responsible for the realization of those projects. They work closely with certification bodies in order to get reports done for permission purposes or order project certification if requested by other project participants. Our interviewed project developers confirmed that competition among certification bodies is satisfying in terms of prices and quality of the services. Quality differences between certification bodies could only be observed in terms of unobstructed collaboration, flexibility and adherence to schedules. Besides, they do not see the need of new manufacturers of turbines in the market. Choice is big enough and collaboration with existing manufacturers works well. If they conducted projects with new manufacturers, problems with financing institution could arise. The minimal requirement of a new manufacturer would be the type certification of the offered turbines. Accreditation is regarded as a quality characteristic. If accreditation was not required by law for specific reports, they would prefer an accredited company over a non-accredited company anyway.

3.6 Standardization bodies

Standardization bodies are not individual stakeholders of quality infrastructure in the narrower sense. In fact, they bundle interests and expertise of different stakeholder groups to further develop standards and guidelines and to achieve a balance of different interests. Most stakeholders which are directly affected by quality infrastructure reported that they collaborate in such bodies and committees. Important organizations for the standard setting in wind energy business are: IEC (International Electrotechnical commission), VDE (Verband deutscher Elektrotechniker, engl. Society of German electrical engineers) , FGW (Fördergesellschaft Windenergie und andere Erneuerbare Energien, engl. German Association for Wind Power Promotion), BDEW (Bundesverband der Energie- und Wasserwirtschaft e.V., engl Federal Association of the Energy and Water Industry).

4 Conclusion

In sum, all stakeholders of quality infrastructure of wind energy business in Germany express confidence in the system. Quality infrastructure services for wind energy sector are of high quality. Voluntary certifications (project certification) are mainly used for offshore projects. Especially banks require project certification in order to foster trust among project participants. Other voluntary quality infrastructure services like component certification can help new players to enter the market. Manufacturers often request certification of components from their suppliers. Therefore, getting products certified is sometimes the only chance to enter the market.

Competition among certifying companies works well. The quality of services is high and prices are subject to competition. Although competition among different international certification guidelines is accepted, our interviewees also expressed concern with regard to national singularities concerning certification requirements and testing in multiple national markets, which increases costs. Even worse, there is a domestic and international issue with regard to the acceptance of test results and procedures. Regarding the basic functions of standards described by Tassey (Tassey 2000), at least the function of information standards is not fully achieved in an internationally uniform manner.

Looking at national requirements for the wind sector in Germany, one can state, that legal requirements are very distinct. Requirements that (potentially) concern a greater public, like the quality and thereby also the safety of turbines or the stability of power grids, are requested by law, others not. For instance in the case of type certification, only the important module of design evaluation (type approval) must be carried out, other modules, which are of less importance for the public, remain voluntary.

Our research provides a general overview on the topic of quality infrastructure in wind energy business. Further research may conduct a company survey on aspects discussed in this paper. Moreover, it is also interesting to compare the role of voluntary quality infrastructure service in emerging markets with our research in Germany where mandatory requirements play an important role. Comparison to other industry sectors could also be of interest.

Since our research focuses on a present perspective on the sector and partly on future expectations, a look into the past seems worthwhile to assess the contribution of quality infrastructure and standards to the emergence of the wind energy sector. Jacobsson/Lauber performed detailed research on the contribution of legal requirements to the emergence of renewables energies in Germany (Jacobsson, Lauber 2006). However, the role of quality infrastructure is hardly touched.

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Institutional Work Within SDO: The Project Leaders' Actions for RFID Standardization

Anne Mione (*), Anne-Françoise Cutting-Decelle (**) Jean-Luc Barraud (***)

(*) Université de Montpellier 1 / ISEM, MRM, Montpellier, F
anne.mione@univ-montp1.fr

(**) Ecole Centrale de Lille, FR and Université de Genève / CUI, CH
afcd@ec-lille.fr

(***) Télémécanique Sensors, Schneider-Electric, L'Isle d'Espagnac , F
jean-luc.barraud@tesensors.com

Abstract: *This contribution focuses on the institutional work required within an SDO (Standard Development Organization) to develop a standard. The example presented here relates to the structuring of the information contained in RFID tags. The involvement of the authors of this paper in standardization enabled to collect primary information but also to follow the two years process from the initial decision phases up to the current situation. This paper also provides a contribution to literature about firms engagement in the standardization process and on the corresponding institutional work. We also highlight how the institutional work requires entrepreneurship and discuss the openness of the standardization process.*

Keywords: *Institutional entrepreneurship, institutional work, standardization, SDO, RFID*

1 Introduction

The standard development as a formal process is drawing more and more attention as formal voluntary standards play an important regulatory role in the worldwide economy. Thibierge (2013) identifies a serious "densification" of standardization. The author enumerates 20 000 standards in 2012, 1 800 new standards per year, 650 000 international technical standards (Perinorm). This densification calls for a better knowledge of the standard shaping process in Standard Development Organizations. Specifically, considering the increasing role of voluntary formal standards -standards that are shaped in Standard Development Organizations (SDOs) - there is a growing need of knowing how does the process really work. What are the specific rules operating and more specifically how can a firm play an entrepreneurial role within a Standard Development Organization ?

Scholarship on standardization has explored firm's engagements in formal SDOs. Blind and Mangelsdorf (2016) exposed the German firms' motives to engage in formal standardization process. Riillo (2013) had attempted to capture firms' different motives to participate into SDOs. Leiponen (2008) identified the profiles and intention of firms participating into SDOs and Mione (1994) described a typology of 150 firms participating into the French SDO according to their strategic objectives. However, as Blind and Mangelsdorf (2016) noted, the studies on firm engagement in a standardization process concerned mainly firms in the domain of industrial consortia in the information and telecommunication sector (Chiesa et al., 2002; David and Steinmueller, 1994; DeLacey et al., 2006; Greenstein and Stango, 2007; Grotne, 2008; Ranganathan and Rosenkopf, 2014), or factors influencing standards battles (Shapiro and Varian, 1999), or else dominant designs (Suarez, 2004), e.g., in the case of computer workstations (Khazam and Mowery, 1994). The standards wars concern de facto standards like VHS vs. Betamax (Cusumano et al., 1992; Gallagher and Park, 2002), or

Sony's Blu-ray vs. Toshiba's HD-DVD in blue laser DVDs (Gallagher, 2012, Gnyawalli and Madhavan, 2008).

As an exception to those cases, the OOXML and ODF case specifically concerns the formal SDO (ISO, The international Standardization Organization) and caught attention from scholars (Blind, 2011; Eygedi et Sheriff, 2008; Vion et al, 2013, Yami et al. 2016). Yami et al (2016) describe the different phases of the ISO standardization process and the relational posture adopted by Microsoft all along these different phases to manage coopetition. Following the same line, we offer to investigate the management of the standardization process to expose the different managerial decisions led to shape a standard draft and to follow it all along the different constituting steps. The originality of our contribution lies in the perspective we adopt: we follow the process from inside the SDO and we examine the process of conceiving, writing and proposing a standard draft in the position of the project initiator. This contribution is the result of the triple perspective combination on the Working Group (WG): the Convener in charge of organizing and following the ISO institutional processes, the industrial partner who initiated the project and the scholar who observed the two years process from the intention to standardize to the progress of the process.

The firms contributing to shaping a standard are identified as institutional entrepreneurs (Narayanan and Chen, 2012). However little is known about the decisions an institutional entrepreneur has to take all along the standardization process, notably concerning openness and transparency towards other stakeholders that can be competitors. As Narayanan (2012) noted, the relation towards others to organize collaboration is an interesting dimension to explore in the standard development process.

To observe this institutional work we examined a real test case: the standardization process of the information structure within RFID tags. For this, we achieved an in-depth analysis of the ISO standardization process from the early beginning of the project to the standardization procedures within the ISO Working group. We adopted the observing method of institutional work (Benslimane et Lecas, 2006) and we specifically used Dumez and Jeunemaitre (2006) strategic sequential sequences to enlighten the decision to standardize and the strategy to manage the standardization process so that it has a chance to become an ISO standard.

The first part presents a review from scholarship in standardization on standard shaping and the specific institutional work perspective on this process. The second section describes the case analysis and the method used. The third part presents the results. We specifically expose the motives of the industrial company to invest in the standardization process. Then we describe the institutional strategy adopted to obtain a standard. We finally discuss the process openness and transparency and we conclude on the entrepreneurial nature of institutional work.

2 Standard Shaping in Standard Development Organizations

2.1 SDO As A Specific Place To Shape Standards

Research on standardization has long time established that standards are set through two main mechanisms, markets and committees (Farrell and Saloner, 1988; Funk and Methe. 2001). Standards issued from market are called "*de facto*" standards. They are issued from market competition. Much of the literature has focused on these standards (Shapiro and Varian, 1998; Schilling, 1998; Gawer and Cusamano, 2002; Sheremata, 2004). Standards issued form technical committees are "*de jure*" standards. They are established by formal standard bodies (ISO, IEC, CEN, ETSI, etc…). As Jain (2012) noted, studies focusing on SDOs are following three major perspectives:

- Some studies have examined how SDOs could resolve coordination problems. Farrell and Saloner (1988) find that committees take longer to reach a consensus than markets but tend to do better. Following this line, Farrell (1996) emphasizes the tradeoffs between the delays inherent in achieving consensus and the benefits of avoiding a costly standards war. Other scholarship in this stream highlights systematic venue preferences by firms (Lehr, 1992; Lerner and Tirole, 2006) and the role that multiple competing standards organizations play in coordinating rule development (Genschel, 1997).
- A second stream of research empirically explores the firm characteristics (Blind, 2016; Leiponen, 2008; Weiss and Sirbu, 1990, Mione, 1994, 2006), the social capital of the engineers serving in these forums (Dokko and Rosenkopf, 2010, Riillo, 2009) and the alliance opportunities created by this (Waguespack and Fleming, 2009, Rosenkopf et al., 2001, Benmeziane et Mione, 2015).
- Another research theme shows how SDO's serve as tools for firms to engage in a strategic behavior (Gandal et al., 2007). The extreme negative perspective on this line denounces the strategy of hiding essential patent within standard and regulatory capture (Stigler, 1971) with large firms volunteering resources that influence the outcome, insiders manipulating procedural rules and players lobbying for their economic interests (Greenstein and Stango, 2007; Cargill and Bolin, 2007, Laffont et Tirole, 1991, Blind et Mangelsdorf, 2016).

To address this concern, we deeply explore how a standardization project is proposed and worked on within a Technical committee. We specifically consider the openness of the process. Openness is claimed by scholars in formal standardization. The formal SDO process enables to produce “open standards” referring to the mode of definition that is public and consensual, to the FRAND policy on intellectual property right and on the interoperability of the specification. In this contribution, we aim at exploring the development of the project regarding openness and entrepreneurship.

Some authors have described the organization of forums as well as the activities taking place within them (Cargill, 1989; Libicki, 1995; Jakobs et al., 2001). However, we consider that a real description from inside the SDO has not been achieved. Jain (2012) addresses the specific question of the situation of anticipatory standard in the situation of innovation and wonders how the committees can anticipate the new markets organizations are going to face. Observing how Microsoft managed the coopetitive situation within the SDO on the particular case of OXML format standard, Yami et al (2016) adopted a dynamic perspective and identified different sequences. In this analysis, the competitive or cooperative contexts were analyzed through the tonality of the mails exchanged. In our contribution, the perspective is closer to the institutional process as we observe it from the inside, following step by step the industrial and institutional initiators. Indeed, in spite of the rich insights of previous analyses led within the SDO process, we still miss a specific description of the actions undertaken within a committee in order to shape, to influence and to lead a standardization project. These actions are generally considered as institutional work and observed through the lenses of institutional entrepreneurship.

2.2 Standard Shaping As Institutional Work

According to Narayanan and Chen (2012), firms developing standards can be thought of as "institutional entrepreneurs" whose innovation is intended to dislodge established institutions in the technological field. Institutional entrepreneurship (DiMaggio, 1988) has gained substantial currency in recent years as a means for understanding strategies used by actors to shape emerging institutional arrangements or to disrupt existing ones (Lawrence and Suddaby, 2006). This includes legitimacy-building efforts (Suchman, 1995; Jain and George, 2007), shaping discourse within a field (Munir and Phillips, 2005; Zilber, 2007) as well as the deployment of social and political skills (Fligstein, 2001; Garud et al., 2002). As noted by Jain (2012), given its focus, applying these concepts to activities taking place within standards development organizations appears a natural fit.

In this context, an institutional entrepreneur faces four sets of challenges (Hargrave and Van De Ven, 2006). The first is *the framing the context ;* a technological change introduces a rivaling new technology, and therefore, an institutional entrepreneur will compete to establish the legitimacy of its own technological trajectory in the public domain. The second challenge is to *enact a collaborative network* of firms whose products and/or services are critical for the success of a core technology standard controlled by the institutional entrepreneur. Third, the institutional entrepreneur must facilitate *institutional arrangements* such as regulating systems and resources allocation. Finally, the institutional entrepreneur *must enact the political and collective processes* through which standards emerge. These four sets of challenges (Hargrave and Van De Ven, 2006) can be complemented by the three specific actions identified by Weick (2011) who made a review on institutional entrepreneurship : mobilize resource, mobilize other actors and create meaning.

Another aspect is an opposition between the strategic intent and the institution perspective. Institutions are sets of practices rather than sequences of individual actions. This means that the institutional context structures the actions. However, the strategic dimension is admitted by Di Maggio and Powell (1983). Concerning this point, this paper is based on Lawrence and Suddaby (2006) institutional work. Following the Di Maggio and Powell (1983) and Garud et al. (2002) findings, Lawrence and Suddaby (2010) develop the strategic dimensions related to institutions. Oliver (1991) already identified strategic responses in the way firms conform to standards. Lawrence and Suddaby (2006) propose different strategies aiming at creating, maintaining or destabilizing an institution. Considering specifically the creation of an institution, they recommend specific actions : "advocacy, defining, vesting, constructing identity, changing normative association, constructive normative networks, mimicry, theorizing, educating" (Lawrence and Suddaby, 2006). In this large spectrum of practices, we focus on the creation of the institution and especially on the "defining" form of institutional work.

A second reserve made by institutional work (Lawrence and Suddaby, 2006; Battilana et d'Aunno, 2009) concerns the individual perspective of entrepreneurship. Maguire and hardy (2009 : 173) observe that "a single actor is unlikely to be responsible for the success of outsider-driven deinstitutionalization of institutional entrepreneurship more generally". In this contribution, we integrate the collective dimension of institutional entrepreneurship as standardization requires mobilizing others (Weick, 2011) and more specifically as the standardization process lies on the motivation of both the industrial initiator and the standardization expert.

Considering literature review we conclude on some elements. First, the increasing role deserved to voluntary standards to regulate international trade creates the need of a better knowledge of the standard development process. Then, the commitment of the company on the process requires further analyses. Which firms and for which motives do firms participate in SDOs have been explored (Blind, 2016; Riillo, 2013; Leiponen, 2008), but how can they conceive, shape and support a standard all along the process remains insufficiently known. Institutional entrepreneurship offers some model to represent the institutional work. Do they apply to standards shaping ? The objective of this contribution is to identify the different institutional works in the standard development process overall the entrepreneurship process. We use Narayanan and Chen (2012) and Weick (2011)'s descriptions of institutional entrepreneurship.

3 Method

Our contribution is based on the in-depth analysis of a specific standardization case study. This case has been considered since it offers three benefits: first, it applies to ISO. ISO (International Standardization Organization) is a typical institutional Standards Development Organization. In the domain of standard development, different organizations operate from official international institutions to the private professional consortia and it is not so clear to qualify the standard development nature. Here, we clearly focus our analysis on an institutional context whose rules are public and readable. Then, this case study concerns the domain of information technology that constitutes a privileged sector to examine standardization stakes. Finally, it is a real on-going situation experimented by two of the authors of this paper. The follow-up of this analysis has been done on strict bases from the early beginning of the project to the present situation, which took two years. Thus, the authors were able to identify and to follow all the stages of the maturation process from the innovative idea through to the development of the standard, step by step, according to the figure below.

The standardization process

phase 1 : the idea, the intent to standardize ;
phase 2 : proposal of a New work item (NWI) : initial document to be completed by the authors of the future standard prior to any discussion and vote together with (or not) a first proposal of a working draft (WD) document ;
phase 3 : initial vote on the NWI (and WD if any) during a plenary session ;
phase 4 : The countries have time period (around 3 months) to analyze and to provide comments on the documents, those comments will then be solved during the following meetings. During the initial stages of the voting procedures, the comments can be either technical, or editorial. Both need to be taken into account and solved during working sessions of the working group in charge of the development of the standard. The results of the comments resolution are published by the WG and circulated among the other members of the parent standardization committee.
phase 5 : According to the results of the votes and the starting point of the ballot procedure, the future standard then becomes CD (Committee draft), DIS (Draft international standard) and finally IS (International standard).

3.1 Context Of The Study, Test Case

The case study refers to the RFID tags. A tag is a memory providing storage facility up to 30 000 characters without any contact. A complete RFID solution is composed of tags, readers, encoders and a middleware allowing the integration of the RFID solution in the company information system. Tags are used extensively in industry, however most of the time the information contained in the tag is stored without any pre-defined structure, thus giving rise to important waste of space and huge interoperability problems.

On the contrary, structured tags allow to locally store the data model (or a part of it) related to the product, thus enabling to fetch the corresponding information applicable to the product without having to connect to a distant database, whence a significant reduction of errors, particularly when compared to barcodes. They also facilitate the automation of logistic processes, such as real time inventory management, supplier management, etc…

Two of the authors of the paper filed a patent on the way of accessing structured data of tag.

The innovation – this does not exist in the industry today – lies in the possibility to read / write data on the tag, thus enabling modifications and update of the information contained. This is made possible independently of the devices used for reading / writing the information of the tag. Since the information of the tag is structured, interoperability is possible as soon as the data model is shared among the different media : pc, telephone, etc. …

RFID tags offer reading/writing possibilities ; this system has been developed within Schneider Electric in order to enable interoperability between production and/or assembly lines, mobile phones, … The benefit of this use is to enable modifications of data during the production process, as required, when and where necessary. Another important benefit offered by the use of RFID tags is to enable traceability of the information related to the product and contained in the tag.

Existing standards for RFID tags apply to the frequency used : ISO has developed RFID standards for automatic identification and item management. This standard, known as the ISO 18000 series[1], covers the air interface protocol for systems likely to be used to track goods in the supply chain. They cover the major frequencies used in RFID systems around the world.

3.2 Data Collection And Processing

This approach, based on the analysis of industrial needs first made internally within Schneider Electric plants (Dayton, USA and Batam, Indonesia), was then extended to different economic sectors, thus leading to the elaboration of the international standard ISO 15531-5x. This standard falls within the framework of the work already done with the ISO 15531 MANDATE (MANufacturing DATa Exchange) standard, in the domain of production management data. ISO 15531-5x is aimed at providing a standardized exchange format of the information contained in RFID tags, thus enabling providers of software and device tools to exchange and to share the information of the tags.

One of the contributor is convener of ISO TC 184 SC4-SC5 JWG8, in charge (among other standards considered by JWG8, such as ISO 18629 PSL and ISO 18828) of the development of ISO 15531 MANDATE and also acts as expert for the French AFNOR CP IDMI committee (*Ingénierie des données et des modèles pour l'industrie*) ; The second contributor works for Schneider and is expert for JWG8 and a member of AFNOR CP IDMI committee. The third contributor is academics and was observer all along the process. She proposed two questionnaires (13 pages and 16 pages) following a number of least 8 working meetings (3 or 4 hours each) with the two experts. The first expert (ISO expert) is referred to as "academics" as she is Professor at Ecole Centrale. The second expert (Schenider expert) is called "industrial". This way of working enabled to have access to rich primary sources of data. The figure below describes the primary and secondary sources used for this contribution.

[1] The seven parts of the standard are : 18000–1 : Generic parameters for air interfaces for globally accepted frequencies, 18000–2 : Air interface for 135 KHz, 18000–3 : Air interface for 3.56, MHz, 18000–4 : Air interface for 2.45 GHz, 18000–5: Air interface for 5.8 GHz, 18000–6 : Air interface for 860 MHz to 930 MHz, 18000–7 : Air interface at 433.92 MHz.

Primary and secondary sources

Primary sources	
Primary sources : with direct access to the documents since the authors are direct participants in the standardization process	
First hand institutional sources	- NWI (New work item) proposal, WD, first version according to the ISO format - Mail exchanged - Meetings / discussions reports : technical questions - Participants - votes
First hand Industrial sources **(Schneider El.)**	- Technical reports - Professional documents : problem statement - Organisation of lessons on RFID and practical sessions for the students - Strategic objectives : seen/described during the visits of the plant - Work with the students, organisation of meetings / discussions during 3 years, visit of the plant once a year for the group of students : around 40 hours per year
First hand technical sources	Work and technical reports made by students from Ecole Centrale de Lille / IG2I during 3 years, 2014, 2015, 2016 : (around 1 000 hrs per year) - special training on standardization, standardization process, SDOs, standards, for the group of students working on the project - project management report, specifications report, quality report, deliverables, videos, brochures, questionnaires, Powerpoint presentations, meetings/discussions reports, visit report, user guides, requirements definitions, mock-ups and software developments, …
First hand marketing sources	Marketing survey made by students in 2015
Secondary sources	
Institutional offical websites	ISO Directives (ref) ---- around 500 pages – ISO web site and portal

4 Results

The results concern the motivations of the firm to participate into SDO and the institutional work achieved by the WG to succeed in achieving a standard.

4.1 Motivation Of Firms To Participate In SDOs

Blind et Magelsdorf (2016) have studied the strategic motives of German manufacturing companies in the electrical engineering and machinery industry to be involved in standards development organizations. Building on the idea that participating into SDO consists in an alliance, they identify four reasons why firm should ally with partners: decreasing technological and market risks, knowledge acquisition, access to markets, conformity to governmental policies. Participating into SDO relates to these four themes and the specific firm objectives are : to enforce the company specification content, to prevent conflicting standards, to benefit from unattended knowledge spillovers, to keep track of other companies technical knowledge, to solve technical problems at the industry level, to solve technical problems at the level of the firm, to acquire competitive advantages through head start in knowledge, to open up new markets , to facilitate compatibility with other producers of complementary products, to define technical specifications in regulations and to reduce barriers to trade.

These different objectives concern all ranges of firms including the firms that are actively contributing to the standard shaping and others that participate only to be informed on technological trends or to keep control on the market evolution. In this contribution, the case analysis allows observing the motivations of the project initiator. Some objectives are confirmed. Especially "Enforce company specification content" and "open up market" constitute the two major goals of the project initiator. The industrial who is initiator of the standardization process exposes the situation: "*Till now, we did not manage to convince the Marketing Department to market this solution. For the moment it is an internally developed product very useful for Schneider Electric since it has been developed for the company and it is currently implemented in three plants : Limoges (France), Dayton (USA) and Batam (Indonesia) ; however this tool is not planned to be implemented in the other plants of the company. The Marketing Department is not convinced of the necessity to market this offer. However, when we discuss with integrators from other industrial companies, they are thrilled about this possibility, they understand very well the benefit of the interoperability enabled by this common structuring.*

Lots of people try to solve those problems, following some kinds of makeshift solutions, papers, but it is complex to describe and to communicate. Software developments are always complex to sell. To our opinion, this product could apply to SMEs since they usually do not have necessary technical resources to integrate systems, thus benefitting from this interoperability, in a cheap way. Compatibility could also be ensured with Android systems. The problem lies in the fact that, generally speaking, Marketing and Automation are completelely separated departments, they do not speak the same language. I know very well the Head of Marketing, our offices are located on the same floor, I see him every day. He tells me : "find a client, first, then we will see … , thus we will be sure that there is a demand". The problem is to convince decision makers ! "In the industry world, technicians are not decision makers".

The standardization process provides an opportunity to open market for two reasons. A common standard to read information on RFID tags increases the value offered by the tag. Here the benefices associated with the network effects apply. If everybody structures the data according to the same model, it will be easier for everybody to collect and to add new information and more generally to manage the information. A larger dissemination is expected from standardization since the use of the tag will be improved. Then, Schneider Electric beneficiates from its own expertise in this domain. Schneider El. contribution to standardization legitimates its advantage and the readers will be specifically designed to read the standardized tags. The second set of results concern institutional entrepreneurhip.

4.2 Institutional Work Into SDO

Narayanan et Chen (2012) identified four sets of challenges : framing the context, to enact a collaborative network, to facilitate institutional arrangements, to enact the political and collective process. We found here these four challenges however they are not sequential. On the contrary, we could identify that a sensible management of the timing of the sequences is essential to increase likelihood of achieving it.

4.2.1 Enact A Collaborative Network

Weick (2011) observed that institutional entrepreneurship is often collective and that it requires "to mobilize resources, to mobilize other actors and to create meaning". This case is specifically a situation in which the standardization project is due to a collective : "*I would say that the initial idea started from a project, provided by Schneider Electric, developed in close collaboration between the Engineering School (Ecole Centrale de Lille / IG2I) and Schneider Electric, spanning over 4 years. Given the results of the work done by the students and the involvement of the supervisors in standardization activities (both of them belonging to the ISO TC 184 SC4 committee, as expert or convener of the JWG8 working group), it seemed logical to propose the development of a new standard based on the results of the project (academics)"* Without this particular relation, the standardization process would probably have never been engaged *: "no, we would not have started*" (industrial) , "*Probably no ? --- but difficult to estimate* ! (academics)"

The collaborative network starts with the idea. Then deciding to enter into the standardization process requires also mobilizing resources and mobilizing other actors (Weick, 2011). "*It is true that common discussions, enrichments benefit from the differences in terms of approaches between the actors* (academics and industrial) ! "*In this case, the discussions were related to the benefits/drawbacks of standardizing the data carried on within a tag : what can/cannot be standardized, why, with which objectives ? and, if we standardize the data model of the tag, will this standard be used by other industrials ? This means : are we generic enough to put on the market a structure that fits the needs of other industrials ?"*

Weick underlines the need of mobilizing resources*. "For an industrial company as important as Schneider Electric, this means a lot of time, a lot of persons dedicated to standardization (industrial and academics)"*. However, the benefits are difficult to evaluate*. "Difficult to estimate the gains expected from standardization – probably important ! (industrial and academics)"*

4.2.2 Enact the political and collective process

The institutional process requires the participation of at least five countries that agree to contribute to the standard shaping and to give name of experts . *"The process of proposing a NWI demands that at least 5 countries (nominating experts to contribute) are volunteers to work in the group to start the standardization process."* "*Most participants of JWG8 come from industry and commerce (stakeholder category as defined by ISO), Academics and research bodies, and NGO. Prior to their participation in the WG, they must be appointed by their NSB or by ISO TC 184 SC4 for the convener of the group. ISO is represented through the involvement of its TMB (Technical program manager). Industrials involved in the group are not competitors since they do not work on the same markets*." However as this committee has been working on different projects since more than twenty years, people know each other, which facilitates the work to be done and the working atmosphere. The personal relations installed between partners in standardization who have spent time to shape different standards in the same domain play an important role in the process. The convener will preferentially invite friendly experts in order to facilitate the standardization process. The working group gathers from 4 to 8 or 9 experts, depending on the session*." When a group starts to work on a project, there is a form of cooperation between the members of the group… No strategies applicable to JWB8, the group is too small, and experts involved …. understand each other very well, They are very friendly in between them !"*

Indeed, the standardization process offers the experts the opportunity to meet and to work together during the one week (twice a year) meeting somewhere in the world. Working together to develop standards creates conditions to tie personal relations. When one of them is in charge of developing a new project, he will naturally sollicit the closest and he ask them to join the group for constituting the necessary pool. Reversely, he will accept to contribute to a project we won't have initiated. This is based on the personal skills and ability to develop social relations and corresponds to enacting the political and collective process (Weick, 2011). Combined with these relational skills, the knowledge of institutional arrangements is useful to give more chances to a standard project to become a standard.

4.2.3 Facilitate institutional arrangements

It is important to know the rules and know how to play with the standardization rules. But it is important to keep in mind the fact that the application of those rules is mandatory to develop international standards. Generally speaking, they are 2 possibilities for developing a new standard proposal :

- some experts would like to "launch" a NWI (New work item proposal), but the proposal is not fully defined and/or there are not enough countries (less than 5) and / or experts : in that case, the project can be considered as open, waiting for other people to contribute ;
- the project is well defined, documented, mature enough : in that case, the NWI is fully defined, the five countries are already known with the experts identified and a first draft of the future standard is proposed : WD (working draft), already formatted according to the ISO rules and template. This way of working can be considered as less open than the first possibility.

The project initiator here selects the second procedure in order not to "kill" the initial proposal, since it has been built on real and existing industrial bases. Inside the committee, openness is guaranteed through institutional rules regulating the voting procedures. *"For the votes within a working group, votes, the following rule applies : 1 vote per expert and for the votes during plenary sessions (SC), 1 vote per country. Members of ISO committees (P- and O-members, only P-members vote) are delegates of their national standards bodies – the members of a country's delegation are drawn from its national mirror committee (if this mirror does exist) and they represent the views of their national members. In contrast, members of working groups are experts who have been nominated by their national standards body and should be aware of their national point of view, but act in a personal capacity.(Ref : Getting started , toolkit for ISO committee chairs, ISO).*

The logic is inside –out: "When proposing a NWI together with a CD document, we expect not to have too many substantial modifications, but rather editorial ones !"

Then the FDIS stage is not mandatory, now skipped by default. This means that, when the DIS meets the necessary approval criteria, the default is to proceed to publication. However, a committee can still decide to include the FDIS stage, and it may be necessary in some cases – for example when a significant number of countries with a major interest in the subject make comments at the DIS stage which result in substantial technical changes.

(Ref : Getting started , toolkit for ISO committee chairs, ISO)

- *at the WD or CD stage, comments can be editorial and/or technical. They need to be solved prior to the next vote and stage.*

- *once reached the DIS stage, the only comments taken into account for a new standard proposal are purely editorial ones."*

The complexity of the standardization world and the specificity of the vocabulary and knowledge used have been described (Cutting-Decelle et al., 2015) in the form of a "vocabulary to express standardization features".

4.2.4 Framing the context

Finally, we could observe that, in some cases, it is only when the whole project is defined, when the experts are nominated, when the standard is totally written and formatted according to the ISO rules that the convener presents the project. Thus, it gives no chance to opponents or rivals to influence or to stop the project. In other words, the project is kept secret until the very last moment when it becomes public. "*We must also mention that in terms of strategy, it is also possible (and sometimes recommended !), when willing to propose a new standard, to prepare, simultaneously, a NWI proposal together with a first version of the future standard (WD or CD –committee draft – if the document is complete enough !). Both will be subject to the ballot process, but it can be a means to spare time in the development process, it can also be a means to foreclose the possibility of a full reconsideration of the document related to the future standard*."

This is all the more surprising as standardization claims for openness. What we could observe was on the contrary the strategy to consolidate the project so that it passes through the different steps without modifications. This is far away the idea of openness, and specifically opposed to open innovation philosophy. This is why we question the concept of openness as it is claimed in the standardization process.

5 Discussion: The Openness Of The Standardization Process

In this section, we discuss the meaning of openness in the standardization process. We suggest different understanding of openness and we differentiate the openness of the market that is the objective of the standardization to the openness of the process.

5.1 Openness Of The Market As The Main Goal Of The Standardization Process

The motives to standardize specifically relates to the openness related to formal standardization. In this sense, standardization is considered as a way to make public, accessible and shared a way to organize information in RFID tags. There is a need for a common grid to read the data of the tag. Standardization is a way to stabilize and to specify this grid. The benefit of standardization lies in the three dimensions of the openness. A first way of understanding openness is considering open as public. Public is opposed here to private. What is part of public domain is available for everybody. Here, the status of a standard enables to constitute a shared reference. There is a true advantage since everybody using the tag knows where the different pieces of information are located on the tag. This common knowledge adds value to the tag as it eases its use. A formal standard is public in a sense that it is available for everybody. However open does not mean free and the standards are sold by the Standards Development Organizations. The advantage of the innovative firm to standardize the innovation is that it considers the benefit of a generalized usage of the technology. It renounces to the advantage of secrecy and it opens the innovation since it searches for a large diffusion in the market. Standardization appears as a way to "open" an innovation meaning to let the public know about it. This advertising is searched since the technology has proven its utility and because the firm is convinced that it will benefit from it. *« This technology has demonstrated its utility in Schneider Electric plants. Our internal marketing department is not so keen on developing such technology for new markets. From our experience, we are convinced about the utility of this product. Developing a standard is a* *way* to market the innovation. The objective of standardization is "*Dissemination of know-how, or at least, of a tested and open methodology"*. This specific case is original as it enlightens the situation where standardization is considered as a way to make up for the lack of interest of the marketing service.

A second way of interpreting openness is interoperability. A standard on the way of locating data on the tag would enable all operators along a value chain to easily collect data and enter new information. A stabilized organization would facilitate the integration of tag data in the whole information system and improve management. The standard will enable any software system to read the data contained in the tag.

A third meaning of open relates to intellectual property. If a standard includes essential patents then the FRAND policy requires that the licences fees be fear, reasonable and not discriminatory. In the specific case of the standard draft on RFID tag standardization, no patent has to be disclosed for the standard shaping. However, Schneider Electric beneficiates from patent on the technology to read data from the tag.

5.2 Openness Of The Process : What Is Questionable For Standardization

The fourth meaning of open differs slightly when used in the context of open innovation. Openness in open innovation (Chesbrough, 2003) refers to a specific mode of innovation where innovation is not secret but shared with others to beneficiate from their contributions. Innovative ideas come from everywhere, from suppliers and customers, universities, governments and private laboratories, from competitors and so on (von Hippel, 2007). Open innovation suggests the involvement of several actors in the process that find ways to share ownership and the common innovation fruit (West, Salter, Vanhaverbeke, & Chesbrough, 2014). In this case, there is some open innovation between Schneider Electric and the engineering school (academics). But the standardization process is not considered as a place to bring innovations. The movement is "inside out". Here, the strategic intent of innovators proposing a draft to the standardization process is not to beneficiate from others'ideas, there is no objectives of improving the innovation. The idea is to open the technology so that everybody can adopt it and adapt to its own environment.

The WG convener confirms this movement between closeness and openness*: "When we speak of open / close, we generally refer to the possibility of disseminating the information related to the NWI at an early stage of the standard development process. At the NWI stage, I would say that the way of working is rather the "closed mode". This "closed mode" is followed all along the process: "Once accepted during the SC4 plenary meeting, the document (NWI + WD) is registered in the work program of the SC, then it will be circulated among the experts of the committee. The document cannot be disseminated outside the experts, since it is covered by copyright rules since the beginning".*

Finally, formal SDOs claim that openness lies on the consensual approach in SDOs. Here also, the conception needs to be nuanced. Actually, the convener has to interpret "consensus". "*It is the responsibility of the chairman of the technical committee or subcommittee, in consultation with the secretary of his committee and, if necessary, with the project leader, to judge whether there is sufficient support bearing in mind the definition of consensus given in ISO/IEC Guide 2:2004. "consensus : General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. Consensus need not imply unanimity. (ISO Directives Part 1, 2011,8th Ed)"*. In this specific case, the standard draft is expected to obtain unanimity "*Unanimity, generally speaking for our internal votes*" but we question the role of personal relations in this unanimity.

Concerning this point, some specific rules are governing openness in the standardization process. Any expert willing to shape or influence standard shaping will be accepted in such committee (WGs) provided the country he belongs to nominates him/her to participate (list of experts provided by NSBs to the Secretary of the SC). What we observed however was not a total openness. The standardization working group is constituted with experts declared on a specific expertise domain, nominated by their own countries. Some are active and presents. These one are used to work together. This situation has two aspects. The five experts, from the five countries necessary to start a NWI (New Work Item), are discussed and their names decided either internally within the WG – or else the Secretary of the SC can send a Call for Experts open to the P-members (NSBs) participating in the work of the SC.

The reverse aspect is the confidence generated by this common work. Opportunism and influence strategies from new comers are immediately detected ; specifically some consultants can participate in the work in order to gather information and then to sell the competence acquired, but they are often isolated – everybody must keep in mind that the work done within the framework of standardization bodies is subject to copyright rules, this means that none of them is allowed to disseminate the work outside the group. Another dimension in this case is that the choice of the SDO was based on contingency and not really on a strategic calculation, with is not conform to Updegrove's findings (2007a, 2007b). For this project, ETSI (European telecommunications standards Institute), or else IEC (International Electrotechnical commission) could have been a reasonable choice as the project also belongs to the domain of Information technology. However the project initiators decided to choose ISO because of their specific engagement and knowledge in ISO and also because the project deals with an industrial use of RFID tags. Here standardization is not a true strategy optimization.

This leads to consider standardization as an entrepreneurial process, based on the motivation of some project initiators with no security on the return. The foundation of such a process can be asked when observing the increasing weight attributed to voluntary standards in the worldwide market regulation.

6 Conclusion

In this contribution, we made an in-depth analysis of the project of achieving an international standard. Using primary information concerning the initial draft to the final phases of the standardization process, we observed step by step the process of developing a new standard, from innovation towards the standard shaping. We contribute to literature on firms' engagement in the process of standardization and on institutional work. Concerning the firms' motivations to participate to SDOs, we could measure the specific motivation of the project initiator. We founf two of the motives identified by Blind et Mangelsdorf (2016) : to enforce the company specification content, and to open up new markets. We then showed institutional work in SDO through showing how practically the convener of the working group behaved in order to increase the chance of achieving the process. This position is original as the practice into SDO by the standardization experts is scarcely investigated. We particularly discussed how institutional work deals with openness during the formal standardization process. We finally argue that the standardization process is entrepreneurial, in a sense that it does not correspond to an analytical process. From this perspective, we suggest another understanding of "entrepreneurship" in the theoretical debate concerning the opposition between "institutional entrepreneurship" (Di Maggio, 1988) and "institutional work" (Lawrence and

Suddaby, 20006). Finally standardization often works as an intuitive process with its specific rules and actions. In an innovative context, developing a standard may also appear as an entrepreneurial experimentation. Indeed, it can be considered as a way for a firm to save time for placing on the market new solutions or new products: to some extent it forces the firm(s) to decide if they want to go on, ... or not !

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Integration of the Fragmented Value Chain and the Application of Company Standards: Do Corporate Groups Standardize More?

Jo-Ann Müller

Technische Universität Berlin
jo-ann.mueller@tu-berlin.de

Abstract: *This study analyzes the importance of internal standardization for the coordination of interfaces in corporate groups as well as the integration of subsidiaries worldwide. Internal company standards create interoperability, codify requirements, transfer company-specific values and knowledge across subsidiaries and act as a tool to develop and manage product platforms. They facilitate the specialization of group members on different stages of the value chain and become the more important the larger is the geographical and cultural distance between subsidiaries. Appling Generalized Ordered Logit Models to data from the German Standardization Panel, a survey conducted among German firms active in standard-setting bodies, it is confirmed that German corporations utilize a higher number of internal company standards than single firms. The results further provide indication for differences in the application of company standards depending on the country of origin: While the effect is highly significant for German multinationals with conservative management styles, no effect is found for the subsidiaries of foreign corporations of which the highest share is located in liberal market economies.*

1 Introduction

Worldwide economic, financial, and cultural integration requires companies to take a global perspective. As market opportunities and growth potentials are immense in global markets, so is competition. International firms simultaneously face strong opposing pressures for customization and cost efficiency (Bartlett and Ghoshal, 1989). The reduction of communication and transaction cost makes possible a fragmentation of the value chain, opening up opportunities to adapt to the rapid globalization by developing complex international strategies (Feenstra, 1998; Krugman, 1995). The focus on core competencies and the specialization of firms that are part of the same corporate group in different stages of the value chain facilitates efficiency gains, optimized sourcing, and access to new markets. Transaction costs are low for processes and products characterized by a high degree of market compatibility and a small amount of company-specific knowledge, providing firms with the opportunity to outsource those parts of the production cycle. If technologies and business practices that diffuse between value-chain activities comprise knowledge that is valuable to the firm, the latter will seek to keep such assets within the boundaries of the firm (Gereffi et al., 2005). If corporate groups locate subsidiaries in the home country it is referred to as domestic insourcing. Multinational corporations (MNCs) in addition establish subsidiaries abroad, so called foreign direct investment (FDI). Coordinating internal interfaces and integrating value chain activities worldwide creates high managing, monitoring and transaction costs. The significant role of standards in value-chain governance is undisputed in economic literature (e.g. Gereffi and Lee, 2012; Kaplinsky, 2010; Gereffi et al., 2005; Gibbon and Ponte, 2005; Nadvi and Wältring, 2004. In particular MNCs face inconsistent pulls through different operating conditions in different countries and one way for MNCs to meet their special need for internal consistency is the application of standards (Fortanier et al., 2011). Studies exist on the link between FDI and international management standards (e.g Guler et. al, 2012; Smith, 2009) and the importance of guidelines and routines in vertically integrated firms is not new by any means either (see e.g. Dowell et al., 2000; Christman, 2004; Jaffee and Masakure, 2005). However, the relationship between internal company standards and the level of integration of the fragmented value chain has yet not been addressed explicitly and empirical evidence on this type of standards is generally scarce. In addition, many of the existing studies that mostly focus on certain industries lack precise definition of and differentiation between various types of standards. I focus on the importance of internal company for the internal governance of corporate groups. The first chapter presents theoretical considerations on the special role of company standards in corporate groups compiled from different threads of literature. It follows the empirical analysis which is based on data from the German Standardization Panel, a unique survey conducted among German firms active in formal standard-setting organizations. The data allow clear distinction between various types of standards and make possible the investigation of differences in the utilization intensity of internal company standard between corporate groups and single firms. the last chapter concludes.

2 The role of company standards in corporate groups

Crucial for the success of international strategies is focused coordination and control of intra- and inter-firm relationships. By codifying information, specifying requirements, and increasing interoperability, the application of standards can reduce transaction costs and facilitates the specialization of companies on different stages of the value chain. Depending on the nature and value of the product, specifications can be more or less easily codified and may or may not be intended for external use. The application of formal standards, which are established by full consensus within standardization organizations such as ISO International Organization for Standardization or IEC International Electrotechnical Commission and therefore have a public or club goods character, may not be appropriate if value chain activities become more complex and include company-specific know-how and resources. Instead, a firm can develop internal company standards which codify and transfer company-specific requirements and information and which, unlike formal or industry standards, are generally not open to public access (Blind, 2004). Internal company standards can arise from two different motives: the coordination of inter-firm relationships and the internal governance of value chain activities (Blind and Großmann, 2014). Firms that specialize in core competencies while outsourcing other stages of the value chain to subcontractors may impose company standards on those external businesses in order to ensure quality, legal security, and compatibility of products. The importance of company standards in disintegrated supply-chain relationships has already been discussed in economic literature (e.g. Großmann et al., 2016; Großmann, 2015; Marucheck et al., 2011). Company standards which are relevant in inter-firm transactions, however, will most likely have an “external” focus in the sense that they do not diffuse firm-specific value. Existing and well-established international standards, such as ISO 9001 for quality management or ISO 27001 for information security, then might be relatively more relevant to the outsourcing firm than the development of own standards. In contrast, the special role of company standards for corporate groups follows from the motives for an integration of the fragmented value chain per se. Complex products and processes as well as high relevance of firm-specific know-how and technologies substantially increase costs for outsourcing. Internalization of value chain activities will, however, be more profitably only if internal interfaces are optimally coordinated, advantages fully utilized and assets kept within the boundaries of the firm. This can be achieved through the development of internal company standards which diffuse within but not out of the corporation. As corporate groups develop diverse international strategies, the level of integration of subsidiaries and, hence, the importance of company standards may vary depending on the role they take within the group (Prahalad and Doz, 1987). Global firms seek to increase efficiency by coordinating business activities on a worldwide scale. Products produced for the global market in few locations are centrally managed and sold under a global brand, generating economies of scale and fostering learning. The key aspect of efficiency seeking investment is that all members of the group jointly work towards a defined set of objectives within the global strategy. Company standards act as a tool to implement harmonized product specifications as well as common organizational practices and values across all subsidiaries of the group. Internal standardization thereby supports the development of a high performance enterprise network with a strong corporate culture (Festing und Eidems, 2011; Forntanier et al. 2011; Dowell et al., 2000). Another incentive to utilize internal company standards is learning and knowledge diffusion (Großmann et al., 2016). Developing routines and knowledge transfer processes within the firm-specific strategic context helps to ensure responsible corporate behavior and to establish a global brand. As the codification of company-specific competencies and tacit organizational know-how requires clear understanding of the processes, company standards also foster learning and product innovation (Großmann, 2015). By diffusing firm-specific know-how and technologies between value-chain activities, company standards transfer high-value assets within the boundaries of the firm which facilitate the exploitation of competitive advantages abroad (e.g. Christmann, 2004; Guler et al., 2002).

Sourcing from well-integrated suppliers is also part of the efficiency strategy. Typically, companies offshore less know-how intensive production stages in order to exploit cost advantages in terms of lower input prices. Due to liability and reputation concerns, MNCs are likely to apply high quality corporate standards to avoid product recalls and to ensure quality (Baake and Schlippenbach, 2011). Internal standardization can serve as a control mechanism that makes possible the monitoring of subsidiary performance (Bartlett and Ghoshal, 1998; Harzing und Sorge, 2003; Mellahi et al. 2015). Quality assurance is essential for the development of a global brand. It increases customer satisfaction and loyalty, thereby improving the global image of the firm and strengthening its reputation (Dowell et al., 2000).

In order to meet specific needs of buyers in different countries, MNCs may need to adopt a flexible approach in which, as far as possible, cost efficiency is maximized through concentrated production, optimal sourcing and centralized organizational activities while manufacturing remains locally responsive if necessary. Pressures for responsiveness arise from cultural, language, economic or regulatory differences between the home and the host country (Prahalad and Doz, 1987). Standardization of product specifications facilitates modularization and the development of product platforms, which makes possible the adaption of products to local demands while economies of scale and scope can still be achieved (Simpson, 2004; Smith, 2009). The development and management of internal platforms in line with a company-specific strategy is complex. As a tool to implement common practices, routines and non-person-oriented information transfer processes, company standards are indispensable for the development of platform thinking and the creation of system stability (Festing and Eidems, 2011; Gawer and Cusumano, 2013). Platforms, however, not only exist within but also between firms in form of supply-chain and industry platforms (Gawer and Cusumano, 2013 and therefore are relevant to both corporate groups and single firms engaging in outsourcing.

If the firm primarily invests in order to serve the local market and products are adapted to local conditions, subsidiaries may as well be granted autonomy and act independently from the group (Prahalad and Doz, 1987). Then internal standardization will be less relevant. Independence of subsidiaries may also vary depending on the management style of MNCs. Following Hall and Soskice (2001), home countries of MNCs can be classified into “liberal market economies” (LMEs), in which foreign subsidiaries are allowed to operate more independently, and “coordinated market economies” (CMEs), in which foreign subsidiaries are deeply embedded in the network and closely supervised. The classic example of a LME is the USA and a country that combines all the characteristics of a CME is Germany. The theory implies that subsidiaries with headquarter located in LMEs are less integrated and therefore become more similar to single companies with respect to the application of company standards. In particular in case of German single companies being the comparison group and if the major role of the subsidiary is to serve the German market, foreign MNCs might apply an even lower number of company standards.

Summing up, corporate groups are expected to apply a higher number of company standards than single firms. Especially for MNCs which face inconsistent pulls through different operating conditions in different countries, company standards are an important tool to create internal consistency. The effects will most likely be larger if they are originated in coordinated market economies and if the main motives are efficiency and resource seeking.

3 Empirical analysis

3.1 Data and variable description

The empirical analysis is based on data from the German Standardization Panel. The survey was conducted in 2013 and 2014 among companies actively participating either in German Institute of Standardization (DIN) or in German Commission for Electrical, Electronic and Information Technologies (DKE). The questionnaire was designed by the Chair of Innovation Economics of the Technical University of Berlin. A fix set of questions gathers information on the implementation of standards, the standardization work as well as general information about the company. Data on the German Classification of Economic Activities from 2008 and the number of employees was matched from Hoppenstedt data base. The final sample consists of 733 unique firms.

The dependent variable is the number of internal company standards utilized by the firm. It is divided into three categories: 0 (N = 113), between 1 and 10 (N = 260), 11 to 100 (N = 260), or more than 100 (N = 100) internal company standards. The independent variable of interest is whether the company has subsidiaries or not. 32 percent of the sample are single firms which are not part of a corporate group. Among the company groups, 62 percent are German and 38 percent are MNCs with headquarter outside of Germany.

Both the number of applied standards and the organizational structure are potentially correlated with size, innovation activities, and extent of internal and external standardization work of the firm. For example, large firms have more resources to develop standards (Blind, 2004) and their value chains are most likely fragmented.

Mean values of the variables of interest are reported in Table 1. Internal standardization work is captured by a binary variable that takes the value one if the company has an own standardization department. An indicator for the participation in international standardization organizations, such as ISO and IEC, indicates external standardization activities. The sample is divided into three groups depending on their innovation activities. The first group did not undertake product or process innovation in the previous year, the second group implemented one of the two types of innovation, and the third group developed both product and process innovations. Corporate groups are larger, more often engaged in internal and external standardization work, more innovative and a higher share operates in the high-technology industry[1]. Table 2 reports pairwise correlations between the potentially confounding factors and the variables of interest: number of company standards and organizational structure. Although correlations are high, especially for the number of employees, there is no indication for multicollinearity problems.

Table 1: Mean values for all variables by organizational structure

	Full sample (N = 733)	Single firms (N = 238)	German corporations (N = 306)	Foreign corporations (N = 189)
Number of employees	6,808	1,026	10,975	7,344
Standardization department	33.15%	22.69%	40.85%	33.86%
International standardization	51.84%	37.82%	54.58%	65.08%
No innovation	10.78%	15.97%	8.17%	8.47%
Product or process innovation	38.06%	44.12%	33.01%	38.62%
Product and process innovation	51.16%	39.92%	58.83%	52.91%
Consumer goods	6.96%	8.40%	4.90%	8.47%
Chemicals, pharmaceutics, rubber, plastic	5.18%	2.52%	4.58%	9.52%
Manufacture of metals and metal products	9.96%	12.18%	10.78%	5.82%
Electrical engineering	23.74%	19.33%	25.49%	26.46%
Mechanical engineering	17.19%	12.61%	19.28%	19.58%
Automotive engineering	3.82%	1.68%	5.23%	4.23%
Local industries and providers[2]	5.59%	6.72%	5.88%	3.70%
Service industry	27.56%	36.55%	23.86%	22.22%
High-tech industry	50.20%	39.92%	53.59%	58.73%
Medium-tech industry	10.91%	12.61%	12.09%	6.88%
Low-tech industry	13.37%	15.13%	12.09%	13.23%

Table 2: Measures of correlations between firm characteristics and variables of interest

	Number of company standards	German corporations	Foreign corporations
		base outcome: single firms	
Log number of employees	0.47*	0.48*	0.48*
Standardization department	0.30*	0.19*	0.12*
International standardization	0.19*	0.17*	0.29*
Innovation activities	0.26*	0.19*	0.15*
Service industry	-0.21*	-0.14*	-0.16*
High-tech industry	0.15*	0.14*	0.19*
Medium-tech industry	0.06	-0.01	-0.09
Low-tech industry	-0.03	-0.04	-0.03

Notes: Pairwise correlations are measured by spearman's rho, *significant at 5%

[1] Classification according to Eurostat (http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries/de).
[2] Includes mining and quarrying, electricity, gas and water supply, oil, and construction.

In order to examine differences in the application of company standards depending on whether the home market economy is liberal or coordinated, Figure 1 illustrates the countries of origin of all foreign MNCs. Following Hall and Gingerich (2009) when categorizing firms, 42 percent of the subsidiaries are categorized as group of liberal market economies with their headquarters being located in the US, UK, Ireland and Asia (other than Japan). Coordinated market economies, for example Sweden, Austria and Denmark, amount to 20 percent. The home countries Switzerland, France, Italy and Luxembourg lie in the middle and therefore belong to the group of intermediate forms.

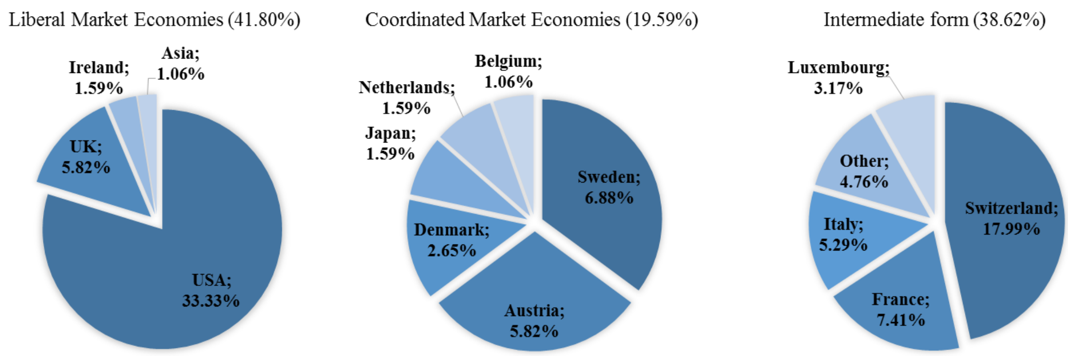

Figure 1: Countries of origin of foreign MNCs (N = 189)

The econometric technique applied to analyze the relationship between the integration of the fragmented value chain and the application of company standards while eliminating spurious correlation is described in detail in the next section.

3.2 Empirical Model

The estimation method to be applied for analyzing the relationship between the number of company standards and integration must take into account the ordinal scale of the dependent variable. First, I run a Generalized Ordered Logit Model that allows to test for the proportional odds assumption, i.e. that the effect is the same for each category of the dependent variable (Williams, 2006). If all explanatory variables meet the assumption, the Proportional Odds Model will be applied. The Partial Proportional Odds Model, in contrast, allows effects to differ between categories of the dependent variable. The response variable is indicated by Y and has four ordered categories j (j = 1, .., C with C = 4). The probability of each category on a vector x of p covariates is given by[3]:

[illegible] (1)

The Ordinal Logistic Model considers one set of dichotomies for each cut-off of the response variable and compares the probability of an equal or smaller response ([illegible]) to the probability of a larger response ([illegible]). In case of the number of company standards the first set compares no versus at least 1 company standard, the second set few versus some and the third set compares the application of a medium versus high amount of standards. As the probability that the response variable equals C or smaller values is always one, C-1 cumulative probabilities are considered. The equation for the proportional odds model is:

[3] Explanations for the formal model are based on Hosmer et al. (2013) and Fullerton (2009).

$$ln\left(\frac{Pr[Y \leq k \mid x]}{Pr[Y > k \mid x]}\right) = ln\left(\frac{Pr[Y \leq k \mid x]}{1 - Pr[Y \leq k \mid x]}\right) = ln\left(\frac{\emptyset_1(x)+..+\emptyset_k(x)}{\emptyset_{k+1}(x)+..+\emptyset_C(x)}\right) \tag{2}$$

$$= \alpha_k - \left(\beta_{1k}x_1^* + \cdots + \beta_{pk}x_p^*\right) - (\beta_1 x_1 + \ldots + \beta_p x_p) \tag{3}$$

where k = 1, .., C-1, α_k is the cut point ($\alpha_1 <..< \alpha_{C-1}$), and β the vector of coefficients. It follows:

$$Pr[Y \leq k \mid x] = F(\alpha_k - x\beta) = \frac{exp[(\alpha_k - x^*\beta_k - x\beta)]}{1 + exp[(\alpha_k - x^*\beta_k - x\beta)]} \tag{4}$$

The probability for any given category j is then given by:

$$Pr[Y = j \mid x] = \begin{cases} F(\alpha_k - x^*\beta_k - x\beta) & k = 1 \\ F(\alpha_k - x^*\beta_k - x\beta) - F(\alpha_{k-1} - x^*\beta_k - x\beta) & 1 < k \leq C-1 \\ 1 - F(\alpha_{k-1} - x^*\beta_k - x\beta) & k = C-1 \end{cases} \tag{5}$$

Parameters are estimated using maximum likelihood estimation.

3.3 Empirical Results

The model results are depicted in Table 3. Column 1, 2 and 3 report the coefficients for the three cut-offs of the response variable. The main independent variable of interest is the binary variable that takes values one if the firm is part of a corporate group and zero otherwise. Further controls are the number of employees, internal and external standardization work, innovation activities and industry dummies. Whether a firm applies internal company standards as compared to not applying them depends on the size of the company, whether it is active in international standardization committees and has an own standards department. The organizational structure, however, has no impact. Likewise, corporate groups do not have a significantly higher likelihood than single companies to apply more than 10 as compared to less than 10 company standards. Only for the last cut-off that compares the application of a medium versus high amount of company standards, the coefficient for corporate groups becomes significant at five percent. That the application of company standards varies between

Table 3: Partial Proportional Odds Model – V1

Number of company standards	Cut 1 0 vs more than 0	Cut 2 0-10 vs more than 10	Cut 3 0-100 vs more than 100
Corporate group	-0.214	0.261	**0.758****
	(0.249)	(0.196)	(0.377)
Log number of employees	**0.355*****	**0.345*****	**0.404*****
	(0.042)	(0.050)	(0.071)
Standardization department	**0.500***	**0.523*****	**1.104*****
	(0.163)	(0.189)	(0.262)
International standardization	**0.158***	**0.409****	0.060
	(0.229)	(0.174)	(0.266)
Innovation activities	yes	yes	yes
Industry dummies	yes	yes	yes

Constant	-0.046 (0.529)	-2.087*** (0.451)	-5.402*** (0.756)

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

subsidiaries can possibly be explained by them taking different roles within the corporate groups. some firms are highly integrated into a global network, others are more independent in order to serve local markets and company standards become less important. This may be true especially for foreign MNCs. According to the FDI report published by Germany Trade & Invest in 2015, 38% of FDI inflows are sales, marketing and supporting. This indicates that market seeking is the main motive for firms to locate subsidiaries in Germany. Another possible explanation could be that the importance of internal standardization differs depending on the management style. Only 20 percent of the foreign MNCs originate from CMEs while the majority of the sample is subsidiaries with their parent firm being located in LMEs, for which internal standardization is less relevant. In order to test this hypothesis, I run the partial proportional odds model differentiating between German corporate groups and Foreign MNCs. The results confirm that foreign MNCs do not apply more company standards than single firms. All other coefficients are qualitatively similar, but stronger.

The results of the third specification of the model, in which German corporations that do not have subsidiaries abroad are excluded, are reported in Table 4 and indicate that the effect is stronger for German multinationals, i.e. companies that undertake foreign direct investment. While there are still some less integrated subsidiaries of German MNCs, as indicated by Column 1, the latter have a significantly higher likelihood than single firms to apply more than 10 company standards (Column 2 and 3). Although not significantly different from zero, the coefficient for foreign MNCs is negative with respect to the likelihood to apply company standards as compared to no company standards. This implies that company standards play a minor role in subsidiaries which are established primarily to serve the local markets and most of which have headquarters in LMEs.

Table 4: Partial Proportional Odds Model – V3

Number of company standards	Cat 1 0 vs more than 0	Cat 2 0-10 vs more than 10	Cat 3 0-100 vs more than 100
German MNC	0.375 (0.332)	**0.371*** (0.223)	**0.851**** (0.394)
Foreign MNC	-0.274 (0.314)	0.204 (0.314)	0.625 (0.421)
Log number of employees	**0.340***** (0.071)	**0.328***** (0.052)	**0.390***** (0.073)
Standardization department	0.356 (0.301)	**0.499***** (0.194)	**1.051***** (0.269)
International standardization	0.079 (0.246)	**0.398**** (0.182)	0.056 (0.277)
Innovation activities	yes	yes	yes
Industry dummies	yes	yes	yes

Constant	-0.164	-2.091***	-5.745***
	(0.548)	(0.468)	(0.856)

Notes: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

As robustness check, version four of the model includes dummies that differentiate industries according to technology intensity to account for the fact that the measure of innovation activities may not be strong enough to capture the level of innovativeness. The results remain the same, but according to the Akaike and Baysian information criterions the model quality decreases (see Table 5). Altering the specification of the dependent variable by merging the first and second category, qualitatively similar effects – as must be expected – become stronger and model quality increases. Linktests are applied to detect specification errors. All models pass the test.

Table 5: Comparison of model statistcs

	V1	V3	V4	V5
	4 cat	4 cat	4 cat	3 cat
Observation	733	687	733	733
Pseudo R2	0.149	0.151	0.154	0.168
Wald test statistic	282.7	267.9	293.2	242.2
Probability test statistic	0.000	0.000	0.000	0.000
AIC	1700	1596	1702	1255
BIC	1893	1799	1922	1384

Concerning the interpretation of the results it has to be discussed another limitation as well. Unfortunately, heterogeneous effects for different subsidiary strategies and the relationship between FDI and company standards cannot be tested directly. Comparing MNCs to single companies reveals differences that result from vertical integration of fragmented value chains in general, which is focus of this paper. No clear statement, however, can be made on whether it is actually the location of subsidiaries in foreign countries that causes the effect. To analyze whether there is a positive impact of FDI on the application of company standards, the preferred comparison group is national corporations, because they are more similar to MNCs with respect to their organizational structure and, hence, hardly quantifiable characteristics such as management skills and resources. Since only six percent of the sample is national corporate groups – a number too small to run an Ordered Logit Model, as maximum likelihood estimation requires a larger number of cases, this must be subject of future research.

4 Conclusion

In the course of global integration international firms face strong pressures to adapt products to consumer needs while at the same time achieving cost efficiency to compete with global competitors. The reduction of communication and transaction cost makes possible a fragmentation of the value chain, opening up opportunities to develop complex international strategies. Crucial for the success of such operations is focused coordination and control of intra- and inter-firm relationships. By codifying information, specifying requirements, and increasing interoperability, the application of standards can reduce transaction costs and facilitates the specialization of companies. If value chain activities become more complex and include company-specific know-how and resources, internal company standards can act as a tool for coordinating internal interfaces and integrating subsidiaries worldwide. They transfer information and knowledge, thereby keeping high-value assets within the boundaries of the firm and facilitating the exploitation of competitive advantages abroad. Internal standardization supports the development of a strong corporate culture and makes possible the monitoring of subsidiary performance. Achieved quality assurance increases customer satisfaction and loyalty, improving the global image of the firm. Standardization of product specifications facilitates modularization and the development of product platforms, which increases flexibility while efficiency gains can still be achieved.

I apply Generalized Ordered Logit Models to empirically test the relationship between the level of integration of fragmented value chain activities and the application of company standards. Controlling for size, standardization and innovation activities, and industry, I confirm that German corporations utilize a higher number of internal company standards than single companies. The results provide indication for heterogeneous effects depending on the role the subsidiary takes within the group. If the main motive for investment is to serve the market, as it is the case for most FDI inflows into Germany, the application of company standards may be even less relevant for the firm. Likewise, subsidiaries of MNCs located in liberal market economies which have a more liberal management style, do not significantly differ from single firms in Germany, a coordinated market economy.

Overall, the results confirm that internal company standards are an important tool for German corporate groups and in particular for German MNCs. Empirical investigation of heterogeneous effects for different subsidiary strategies and the relationship between FDI and company standards remains subject for future research.

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Technical and Technological Standards in Coopetition Longevity: The PSA-FIAT Alliance

Alessandro Nicolosi & Anne Mione

University of Montpellier
MRM - Montpellier Research in Management
a.nicolosi@montpellier-bs.com
anne.mione@univ-montp1.fr

Maria Cristina Longo

University of Catania
Department of Economics and Business
mclongo@unict.it

Abstract: *In this paper, we consider the role of standards in contributing to the alliance longevity. Exactly, we wonder if technical and technological standards have a favourable impact to maintain the alliance in spite of the difficulties associated to collaborating between competitors. Our idea is that technical standards may favour the alliance longevity because they reduce the alliance relational risks and that technological standards may favour the alliance longevity because they help to reduce the performance risks of the alliance.*
We study the PSA-FIAT alliance and especially their joint venture (Sevel). This case is a special coopetitive alliance that lasted more 35 years. It enables to compare the longevity of the two sites covered by the alliance: SevelSud that is still functioning and SevelNord that has ended en 2014. We evaluate their implementation of technical standards in both sites and their respective performances. As a result, we have not perceived a relation between longevity of the alliance and the use of technical standards. However, we find a relation between the longevity and the ability of one of the site to have created a technological standard (a dominant technology).

1 Introduction

Time horizon is not the key factor to measure performance of alliances as both short and long time horizons have a positive effect of alliances on innovation (De Man and Duysters, 2005). However, many studies about strategic alliances show that 15% of joint ventures disappear in the first two years of existence and more than half do not reach the sixth year of their creation (Kogut, 1989; Park and Russo, 1996; Leung, 1997). According to Meschi (2004) seven of ten alliances do not go beyond ten years of life and the instability rates show an alliance on two ends in her first stage. Kogut (1989) identifies a first peak of international joint ventures mortality in their third year and a second in the sixth year of their life (Shi, 1998; Pangarkar, 2003). This is the reason why we consider that alliance longevity deserves a specific attention from scholarship.

We consider equity alliances (Yoshino and Rangan, 1995) that have a common joint venture (JV). Interruptions in these alliances are due to different factors. Das and Teng (2001) identify relational and performance risks as factors to interrupt interfirm alliance. Relational risks are concerned when a partner does not appropriately commit to an alliance and fails to behave as expected. Performance risks regard the factors that may impede achieving alliance objectives. Thus, first nature of risks concerns interfirm cooperation process at internal level and second nature concerns the result of cooperation and its ability to reach the objective. In this contribution, we examine the role of standards in contributing to reducing both types of risks in coopetition relationship.

Our main aim is to observe how technical and technological standards are two factors to the maintenance over time of a coopetitive relation. Technical standards are mentioned in some researches (Gnyawali and Park, 2009; Mione, 2009) like potential drivers for coopetition but their role as a long-term benefit, in a strategic alliance, remains insufficiently explored. In this paper, we consider the role of standards in contributing to the longevity of an alliance. Our main question is: How do standards support the management of coopetition strategy? To answer these questions, we identify two sort of standards. Technical standards are devices enabling the firms to interoperate. Creating a joint venture and organizing the common operations requires common technical standards and we wonder if the choices in adopting standards have provoked tensions between the partners. Another understanding of standard - e.g. technological standards - evokes the domination of a technology over its rivals (Suarez, 2004). We will adopt this technological perspective and wonder how the evolution of the technologies over time and specifically, the opportunity for one technology to become a standard, has played upon the coopetitive alliance duration.

We explore a thirty-years-old joint venture between two partners that are rivals in the automotive industry (PSA and FIAT) through an in-depth analysis and examine to which extent standard strategy has enabled this longevity. We specifically show that a specific technological standard in the light vehicle segment has comforted the performance of the alliance and thus prolonged its longevity.

This contribution is structured as follows: the first part presents literature review on the longevity alliance and specificities of the different nature of standards according to this issue. The second part presents the case analysis context and the data collection method. Finally, we present results and discussion.

2 Theoretical Framework

2.1 Longevity as a Challenge for Coopetitive Alliances

Coopetition concept digs on specific difficulties and tensions that happens in alliances between competitors. Coopetitive alliances are strategic alliances where partners achieve an incomplete interest (and goal) congruence (Dagnino and Padula, 2002, p. 3; Bengtsson and Kock, 2000). Original studies, in fact, describe coopetition as a strategy that includes simultaneously cooperation and competition and that gives rise to a coopetitive system of value creation (Brandenburger and Nalebuff, 1996). Park and Russo (1996) use joint venture (JV) terminations as outcome measurement, finding that cooperation with competitors in a JV is more likely to fail. In addition, Park and Ungson (2001) argues that alliances with strong rivalry are more likely to fail, because it is difficult to develop trust-based relationship, to create an efficient governance structure, to share knowledge and skills, to resolve organizational dissimilarities and to develop a coherent strategy (Peng *et al.*, 2012). Thus, an alliance between competitors hardly survives in the time.

Generally, coopetition strategy is a source of value but also of instability and tensions (Bengtsson and Kock, 2000; Fernandez, Le Roy and Gnyawali, 2014; Gnyawali and Park, 2011; Lacoste, 2014; Raza-Ullah *et al.*, 2014) deriving from combination of two opposite dimensions: cooperation and competition. Tension is multidimensional and multilevel. Fernandez, Gnyawali and Le Roy (2014) distinguished coopetitive tensions on three levels: inter-organizational, inter-organizational and individual (Le Roy and Fernandez, 2015). Le Roy and Fernandez (2015) in their research, explain the most common tensions for each level. Thus, at inter-organizational level, first tension comes from to shared value and ownership of private value (Le Roy and Fernandez, 2015; Ritala and Tidström, 2014). Then, tensions arise between integration components and knowledge distribution (Le Roy and Fernandez, 2015; Oliver, 2004) and finally, another type of coopetitive tension comes from information privacy of risk transfer and technological imitation. At intra-organizational level, there are two main sources of coopetitive tensions: 1) between different business units (Luo *et al.*, 2006) and 2) concerning employees that are involved in activities developed with competitors. Finally, at individual level, coopetitive tension may occur for different reasons. Individuals face the dilemma of choosing between an individual strategy and a collaboration strategy (Le Roy and Fernandez, 2015).

Literature identifies two principles of coopetition management: separation and integration principle. According to separation principle (Bengtsson and Kock, 2000; Pellegrin-Boucher and Fenneteau, 2007), companies compete in some markets and cooperating on others or, as supported by Bengtsson and Kock (2000), companies can achieve simultaneously the competition and cooperation by placing them on different links in the value chain. For example, they can cooperate on R&D and compete at commercial level (Bengtsson and Kock, 2000). Another way to separate the competitive cooperation is assign cooperation to a third-actor who will be responsible to manage it (as a professional syndicate (Bengtsson and Kock, 2000), a client (Castaldo *et al.*, 2010) or a public actor (Fernandez et *al.*, 2014)). However, separation principle poses a problem (Pellegrin-Boucher and Fenneteau, 2007) at internal division level: each not including the role of the other. For this reason, several authors recommend to apply the integration principle (Clarke-Hill *et al.*, 2003; Boucher-Pellegrin and Fenneteau, 2007; Chen, 2008; Fernandez *et al.*, 2014). Rather than simply completely separate the two dimensions specializing them, it seems necessary that individuals incorporate the paradoxical logic of coopetition. This allows each individual to understand its role in the organization and the reasons that lead some employees to be in a position of cooperation with the competitor (Granata and Le Roy, 2014). The question that remains is: What is the role of technological standards to favor coopetitive alliance survival?

2.2 Technical, Technological Standards and Alliance Longevity

The question of the nature of standards is very complex and we choose to differentiate technical and technological standards.

2.2.1 Technical Standards

A technical standard is an established norm or requirement concerning technical systems. It is usually a formal document that establishes uniform technical criteria, methods, processes and practices. A technical standard may be developed privately or unilaterally, for example by an institution or a corporation. The International Organization for Standardization[1] defines a

[1] The most important Standard Setting Organization (SSO).

technical standard as *a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose. A standard can apply to a technology, a protocol, a format or a language. The creation of new technical standards (by Standard Setting Organizations, SSOs) can follow several main processes: de jure, de facto, and industry-created standards*.

A typical form of technical standards are "de jure standards". *De jure* standards are normally created by formal SSOs following procedures that have been established by these bodies. These standards are defined as *a document, established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context* (ISO/IEC Guide, 2004). However, this definition does not include the *de facto standards* i.e. the standards that are set by forces of the market and not by a recognized body (Riillo, 2009). A custom, convention, company product, corporate standard, etc. that becomes generally accepted and dominant is called *de facto* standard.

According to De Vries (2006), there are three groups of standards: 1) *basic standards* (terminology standards, standards specifying quantities and units), 2) *requiring standards* (that set requirements for entities or relations between entities) and 3) *measurement standards* (that describe a solution for measuring). Requiring standards include *performance standards* and *design-based standards* (De Vries and Verhagen, 2016). Generally, standards may apply to products, services, processes, systems and organizations, and may differ in their degree of obligation (De Vries, 2006). For this reason, standards literature presents a large list of types of standards: *voluntary* vs *statutory*, *de jure* vs *de facto*, *public* vs *industry* vs *proprietary*, *proactive* vs *reactive*, *base* vs *functional* (Jakobs, 1998). Most standards are *voluntary* but market situations could make a standard *de facto* compulsory, for example, when customers prescribe certain standard (De Vries and Verhagen, 2016). A same standard can be voluntary for one actor and *mandatory* for another. Therefore, some standards are prescribed but there is often a possibility to conform to the legal requirements in another way than by implementing the standard (De Vries and Verhagen, 2016). Generally, technical standards may exist as:

- Published documents that govern the workings of a specific industry;
- Private documents owned by an organization or corporation;
- Documents publicly available under intellectual property.

As has already been said, an institution or a company may have its own technical standards or, in the case in which they operate in a same sector, the government may have fixed norms valid for all (industry standards[2]). In this case, for example, several companies operating in the same sector would be controlled and managed with the same technical standards. This may facilitate the creation of partnerships between the partners. Thus, technical standards have a direct impact on relationship between two or more partners, especially during the alliance's first stage. Since they are common protocols within a sector or a market, they necessarily evoke the idea of compatibility and integrity. They regulate, therefore, the alliance context because they represent "contracts" that should be respected. In this sense, then, they allow an alliance to remain stable over time.

[2] Accepted requirements followed by the members of an industry.

2.2.2 Technological Standards

Technological standards are measures that prescribe the technologies that are authorized for use. Technological standards can generate economies of scale on both the demand side and the supply side simultaneously. As in the case of production economies of scale, network effects may be exhausted at scales smaller than the entire market. Competition can take place between rival systems much as in the automobile case. Sometimes, however, the benefits of compatibility are so great that the network effects are not exhausted at any scale smaller than the entire market (Langlois, 1999). Technological standards are the result of innovations and compatibility of network connection between products and processes (Buttà and Longo, 2012). In literature, some researchers use the term *dominant design* as synonym of *dominant technology* (Arthur 1988; Anderson and Tushman 1990; Schilling, 1999) but distinction is clear. While *dominant design* indicates the specific elements defining the architecture of a product, *dominant technology* is a technology that has reached a market share of over 50% for a significant period in a category of product or service (Buttà and Longo, 2012; Suarez and Utterback, 1995). Thus, a dominant technology is the result of a successful standardization process. We intend this success both in terms of durability both in terms of performance.

Developing technological standards require a standardization process. Standardization can promote innovation on the market. Therefore, standards play also an important role on the market stability. Indeed, compatibility induces users to converge around a single technological system rather than support multiple systems, and this convergence forces one technology to become dominant over time (Schilling, 2003). Compatibility can be considered as embedded in the technological design, which enables the product to be used with other products (Suarez, 2005).

Finally, we choose the term of technological standard to design a situation where a technology has become well identified. Suarez (2004) admitting that terms are confusing between "industry standards", "technological standards" "dominant designs", elects the term "technology dominance". In this contribution, we choose "technological standard" to refer to a technology that is well known and constitutes a reference on the market. This does not signify that all the market has adopted this technology. This signifies that it constitutes a shared reference and that rivals situate their offer relatively to it. The perspective of becoming leader on a technology and creating the reference constitutes a stabilizing objective of alliances. This is another way of considering the role of standards in the longevity of an alliance.

If two allied companies intend to develop a new common technology, the time axis plays a very important role, especially if the companies are competitors. The companies cooperate in R&D and share the costs of manufacturing and design but, because they are in a competition situation, the time axis helps manage the tensions that can arise between them. So, time from a side, helps to manage a good cooperation for a common project and in the other side, it helps to manage the tensions that can arise since cooperation and competition occur in the same time. Table 1 summarizes the differences between standards.

Table 1: Technical and Technological Standards Definitions

Criteria	Type	Definitions	Authors
Setting Consensus	De facto	Established by the market forces without explicit consensus	David and Greenstein (1990); David (1985); Den Butter (2007); Abernethy (2002); Maxwell (2006)
	De jure	Established by SSOs	
	Voluntary	Established with the consensus of market players	
Economic Problem Solution	Compatibility/ Interface	Specify properties that a product must have in order to work in a system	Farell and Soloner (1985); David (1985); Tassey (1987); Besen (1995); Swann (2000); Temple *et al.* (2005); Iversen (2001); Den Butter (2007)
	Minimum Quality/Safety	Specify minimum product or service performance	
	Variety Reduction	Limit range of characteristics or product or service	
	Information/ Measurement	Provide codified knowledge and recognized test	Krechemer (2000)
Scope	Internal	Relevant inside the company	Slob and De Vries (2002)
	External	Allow external relation of the company	
	National	Relevant for domestic market	
	International	Relevant for global market	Blind (2001); Hudson and Jones (2003); Yan (2007)
Object	Prescriptive/ HOW	Prescribes the production process	Hesser *et al.* (2007); Sahay and Riley (2003); CIE (2007)
	Propositional/ WHAT	Settle characteristic that a product or a service has to have	
Public Good Content	Product/Specific	Give direct competitive advantage to one market player	Tassey (1999); Langlois (1999); Shintaku (2006)
	No-product/Basic	Neutral to the competition in the market	
Timing Respect Innovation	Anticipatory	Settled before the market acceptance of the emerging innovation	Blind (2001); Söderström (2004); Egyedi and Blind (2008); Mione (2015); Sherif (2015)
	Enabling	Developed during the penetration of the innovation in the market	
	Responsive	Settled when the innovation is well established	

Source: adapted by Riillo, 2009 pp. 2-3

2.3 Developing Standards in Alliances with Competitors

Some authors (Gnyawali and Park, 2009; Mione, 2009) have already considered technical standards as drivers of coopetition. Especially, standards organize the basic conditions of the functioning of the market and their existence is required by exchanges in an industry. According to Chin, Can and Lam (2008) cooperation helps creating a bigger business pie and a business can win a bigger piece of the pie through competition. For example, one early DVD standard was the super density format developed by seven firms (Chin *et al.*, 2008).

Several researchers have elucidated the factors enhancing why firms to cooperate with their competitors. The firm gains an advantage cooperating with firms sharing a technological convergence to same target (Chen, 2008; Gnyawali and Park, 2009). Hamel, Doz and Prahalad (1989) and Teece, (1992) note that competitors often achieve substantial gains by cooperating in the development of a new compatible technology. In this case, pre-alliance situation has a very important role. When technology development activities of the alliance being, rival firms will often possess incompatible technologies. Each firm has an incentive to make the alliance's standard compatible with its pre-alliance technologies, but it is almost impossible for the alliance's standard to be compatible with all technologies originating from rivals (Axelrod, 1997). In choosing among competing standard-setting alliances a firm cannot determine *a priori* whether an alliance's standards will succeed, how profitable the standards will be, and what proportion of any profits the firm will garner. Axelrod (1997) says that firms rank preferences over competing alliances for two significant motivations. Firstly, because the probability that a technology becomes a standard increases as the aggregate size of firms offering a compatible product increases. Secondly, the author assumes that cooperate with a rival might increase the alliance's aggregate size and so increase the chance that the alliance's proposed standard will be adopted, the rival may be able to engage in effective price or product competition in the post adoption market for the standardized good. Therefore, firms will prefer to join an alliance in which rivals have as small a presence as possible (Axelrod *et al.*, 1995).

Partners prefer creating a joint venture as solution to high competition. Cases in which firms offer functionally equivalent but incompatible technology will lead to rivalry between them in the standard setting process, because one or both firms would have to abandon a profitable proprietary standard by becoming partners. The intensity of rivalry will be particularly high among firms that have similar market segmentation profiles, because the rivalry will occur throughout the firm's operation. By contrast, the intensity of rivalry will be lower among firms that have different market segmentation profiles because they do not meet head in all markets and because they will often possess complementary technical and market-related skills owing to their different experience.

Finally, we conclude that two nature of standards may affect the longevity of a coopetitive alliance. Technical standards may affect the organizational management of alliance. From an organizational perspective, a joint venture necessitates common references, protocol and knowledge share. Sharing particular specifications is likely to stabilize the relations between partners because it reduces the coordination cost. A second view focus on standardization process, e.g. the tendency of a technology to dominate over alternatives. This view highlights technology evolution and its impact over time over the performance of a technology alliance. Both natures of standard influence the risks of an alliance: technical standards may constitute a relational alliance and technology standard may constitute a risk of performance. The case analysis shows how risks were managed or how they have entailed the rupture of the alliance.

3 Methodology

3.1 The Single-Case Study

The single-case study is an appropriate design under five rationales (Yin, 2013). First, it is a *critical case* in testing a well-formulated theory and it meet all of conditions for testing, confirm or extend a theory. The case represents an *extreme case* or a *unique case*. A third rationale for a single case is the *representative* or *typical* case. The objective is to capture the circumstances and conditions of an everyday or commonplace situation. *The case study may represent a typical project among many different project, a manufacturing firm believed to be typical of many other manufacturing firms in the same industry* (Yin, 2009, p. 48). A fourth rationale for a single-case study is the *revelatory case*: an investigator has an opportunity to observe and analyze a phenomenon previously inaccessible to social science inquiry. Finally, it is the *longitudinal case*: studying the same single case at two or more different points in time.

3.2 The PSA and FIAT Alliance

The PSA-FIAT alliance is remarkable because it is atypical and it can query the dimension of time precisely because it is exceptional in its duration. First of all, the alliance between Peugeot and Citroën was born in 1976. It was an acquisition where Peugeot (acquiring company) receives the assets and the liabilities of Citroën. All interests are grouped under a holding company: PSA Peugeot-Citroen controlled by the Peugeot family with 30% stake.

This alliance produces the *Sevel* joint venture for the production of commercial vehicles. The cooperation agreement covers the development and manufacturing joint of a utility vehicle. A joint venture is created in Atessa (Italy): *Sevel S.p.A* (European Society for Light Vehicles) or better known as *SevelSud* controlled by FIAT. It is 50% owned by Fiat, 25% by Peugeot and 25% by Citroën. In 1988, another firm is established in France, at Valencienne, *SevelNord* controlled by PSA (Jolly, 1997). Figure 1 shows this alliance and its effects: the productions as marks of commercial vehicle enjoying the same technologies but sold by PSA or FIAT under their own brand.

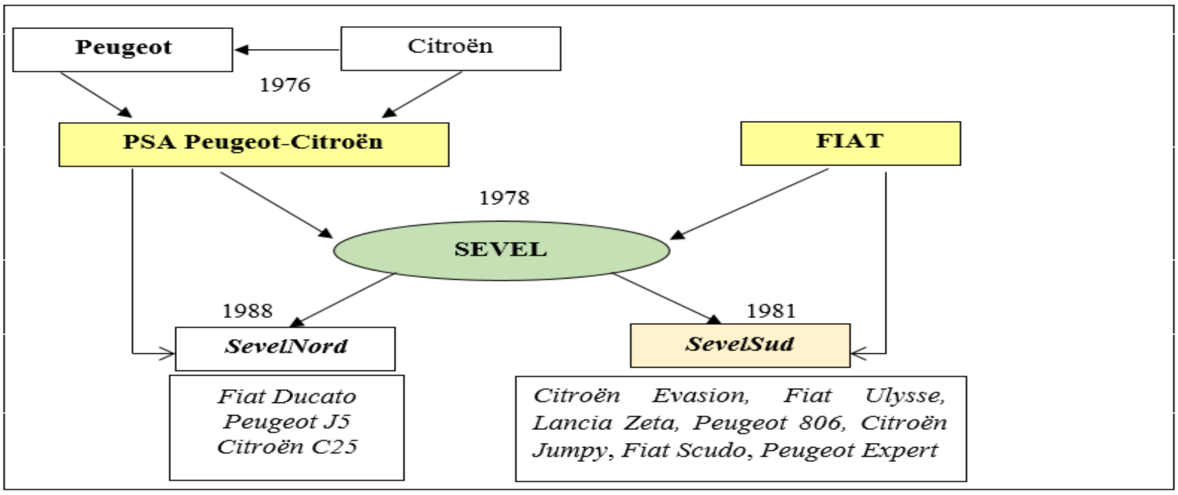


Figure 1: The PSA - FIAT alliance

3.3 Data Collection and Analysis

We adopt an in-depth case analysis. We realize an historical review of annual reports from PSA and FIAT all along the alliance duration and evaluate the financial reports of Sevel JV (two entities in Italy, SevelSud, and France, SevelNord). In order to identify the relational risks of the alliance we identify strategic sequences and key events that are likely to entail relational risks (Das and Teng, 2001). We consider financial performance (production and benefices) through the profit and loss analysis of Sevel JV. We did four interviews covering a two-year period from the director of the JV to comment on these risks and performances of the alliance. We could compare two sites issued from the alliance, SevelNord where PSA and FIAT alliance ended in 2014 and SevelSud that is prolonged sine die.

4 Results

Developing simultaneously competition and cooperation with the same partner-opponent, leads to separate these relationships in the time. As shown, the literature presents different ways to separate the two poles of cooperation and competition. A first way is to develop competitive relationships in certain markets and cooperative relations on others. Another way to separate them is to work on some elements of the value chain and compete on others. For example, two companies can work together on R&D while competing very strongly on the final products (Bengtsson and Kock, 1999, 2000). "Other functions can be pooled as marketing in the case of the promotion of a common brand or in the case of supply" (Fernandez and Roy, 2010). In our case, PSA and FIAT coopete thanks to a perfect alternation between cooperation and competition (Figure 2).

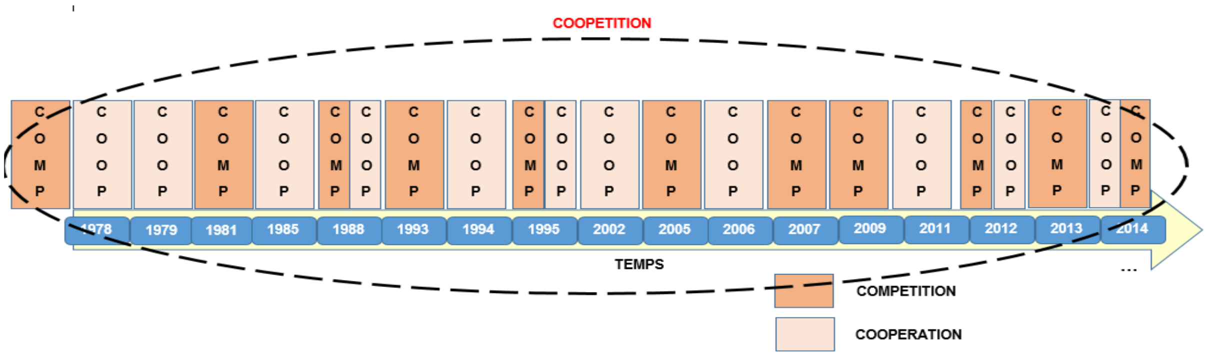


Figure 2: The moments of cooperation and competition in Sevel

As we know, the moments of competition make the strategic alliance rupture but this is not the case for PSA and FIAT. The two partners live together in perfect harmony for a compatibility question at two levels: they are the only big companies that working in the industry of Light Vehicles in Europe and they have produced a successful product that dominates in this sector. These two levels are, necessarily, linked to the standards role.

So, we want to analyse the impact of the management of technical and technology standards on the coopetition longevity. We wonder if technical or technological standards have had a favourable impact to maintain the alliance in spite of the difficulties associated with collaborating between competitors. Our idea is that technical standards have favoured the alliance longevity because they helped reducing relational risks of the alliance and that technological standards have favoured the longevity of the alliance because they helped reducing the performance risks of the alliance. Technical standards may have facilitated the maintenance of the alliance for compatibility and practical reasons. Technological standards may have facilitated the maintenance of the alliance because the alliance created a technology that became dominant and obtained the status of a technological standard.

4.1 Technical Standards and Relational Risk of Coopetitive Alliance

The creation of PSA and FIAT alliance required the implementation of common standards. The decision to favor the standards used by one or the other partner can provoke relational tension. Cusumano and Gawer (2002) and Benmeziane and Mione (2014) have shown how the choice of standard related to the position as a leader or a complementor in a platform. Here, the Accounting Director of the JV (SevelSud) explained that this choice was not problematic as the standards chosen was the standards associated with the motorhome technology were new to both partners: *"We decided to implement the new technology and adopted commonly the standards associated (Accounting Manager, SevelSud)"*. Indeed, FIAT and PSA merged in order to adopt the motorhome technology that was already installed in United States but that was new in Europe.

The main technical standards applying to the motorhome technology were issued from the American Institute of Standardization[3] and Sevel adopted these standards in the factory. Apart from these standards that are specifically associated with the technology, the JV adopted a strategy of adopting widely diffused international standards (ISO standards) and obtained certification in the automotive sector (ISO 18000 on work security and ISO 50001 on energy savings). On the industrial site, standards and specifications have been shared to enable a common work between FIAT and PSA. These standards organize compatibility, interoperability and complementary to practically realize operations and may or may not be shared with complementors on the platform (Cusumano and Gawer, 2002). As far as technical standard are concerned we could identify no differences between SevelSud and SevelNord. SevelSud maintains its activity while SevelNord interrupted its activity in 2014. For this reason, we do not identify a specific role in the adoption of technical standards regarding the longevity question. As the alliance is coopetitive and gathers two competitors, we could have expected tensions associated with the adoption or promotion of technical standards. Specifically, we thought that the choice of technical standards could have entailed difficulties in the relational management of the alliance (Das and Teng, 2001). The firms have their own way of considering problems. Technical standard lies on a particular representation of reality and we could have met cultural differences between French and Italian conceptions. However, this is not what we observed. We could not identify difficulties associated to technical

[3] 12-Volt Electrical Requirements (specified by ANSI/RVIA LV Low Voltage System Standard): addresses the interfacing of the original chassis manufacturer and the RV manufacturer designs to be compatible, requires listed lighting fixtures and other devices and appliances to be installed in accordance with manufacturer's written instructions.
120-Volt Electrical Requirements as specified in Article 551 and other applicable sections of NFPA 70, of the National Electrical Code: ground fault protected receptacles are specified where they are appropriate, only listed electrical fixtures, appliances, equipment and materials that have been labelled by nationally recognized testing agencies are allowed.
Fuel Systems and Equipment as specified in ANSI/NFPA 1192 Standard on RV's: venting requirements for propane appliances are specified where necessary. Fire and Life Safety Requirements as specified in NFPA 1192 Standard for RVs: interior finish flame spread limitations are required, minimum exit facilities providing unobstructed travel to the outside of the vehicle must be available.

standards on the micro level of the JV (firms technical standards), the meso level of the platform (industry technical standards), nor at the macro level of the firm (International technical standards) the main important difference in both sites which concerns the management of the technological standards.

4.2 Technological Standards and Performance Risk of Coopetitive Alliance

We relate technological standard to the measure of performance because we assume that a dominant technology enables to beneficiate from a good position on the market and from the notoriety and expertise that may beneficiate to different models. We also assume that a firm succeeding in installing a technological standard on the market will have more chance to survive over time. For these reasons, we analyse the two sites according to the technology employed and the models produced and evaluate the respective performance longitudinally over the thirty years of the alliance. We then observe and compare the production and then financial performance.

First, we identify a technological standard in the sector. The dominant technology is Motorhome. Precisely, a motorhome (or motor coach) is a technology that offers living accommodation combined with a vehicle engine. Motorhomes are part of the much larger associated group of mobile homes and include caravans and static caravans. The Sevel JV (SevelNord and SevelSud) is specialised in the light vehicle sector (where this technology is dominant) and includes two categories, Multi-Purpose Vehicles (MPV) and Recreational Vehicles. Exactly, SevelSud (our analysis) produces multi-purpose vehicles and it is the only company in Europe that creates Fiat Ducato model. SevelNord also bases its production on Motorhome technology however, it does not specialize in a particular model. In the following figure, we present the Motorhome technology and the associated vehicle sectors.

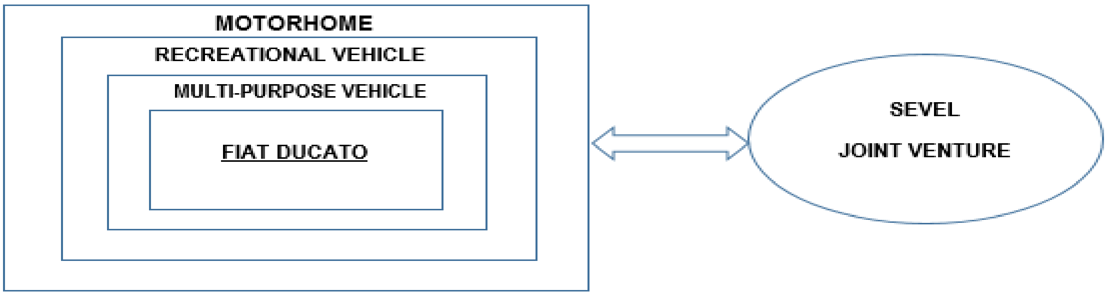


Figure 3: The Motorhome technology and the associate sectors

Regarding the adoption of the technological standard on the duration of the alliance, we observe differences between SevelSud and SevelNord. The alliance is built to implement the motorhome technology. SevelSud (called Sevel before the creation of the second site) starts to exploit the technology in 1981 while SevelNord will only begin in 1988.

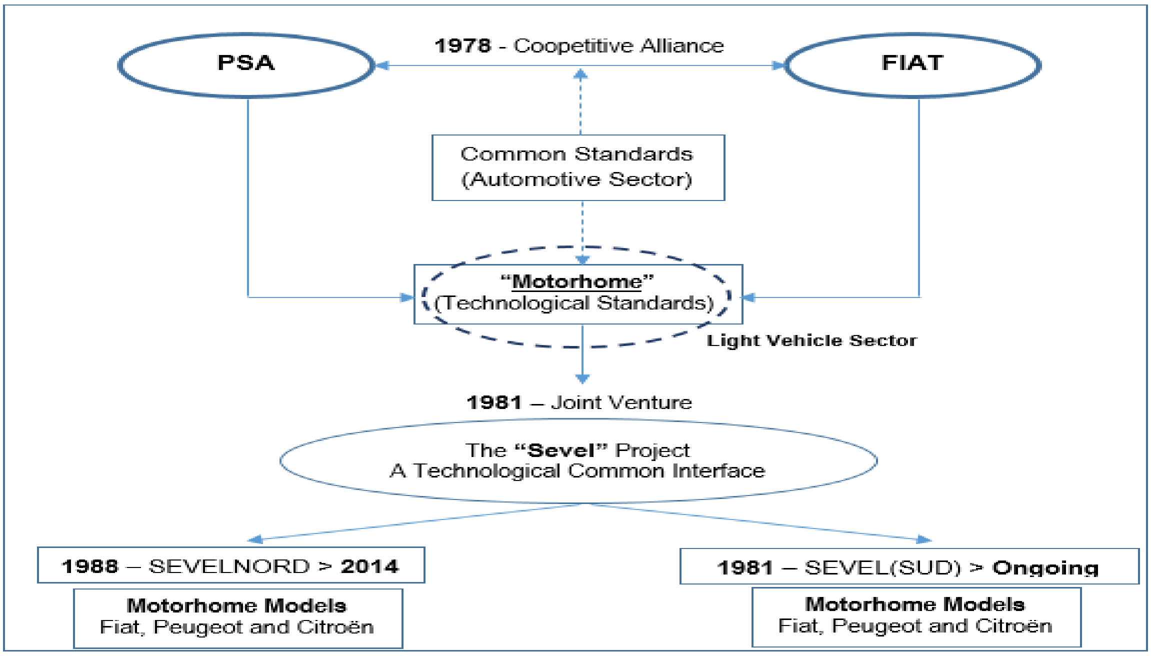
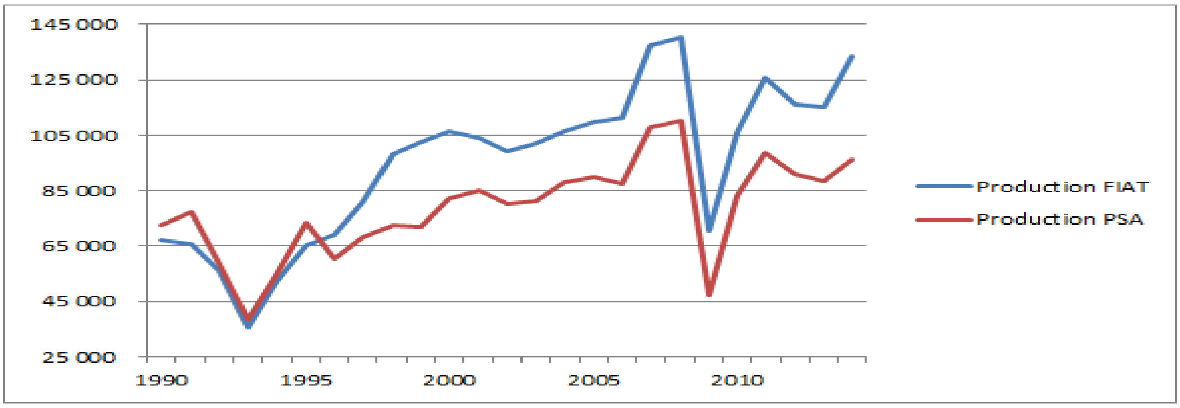


Figure 4: Alliance, standards and duration

The two partners pool their technologies, work under the same technological standard (Motorhome) and yet sell the models according to their own brands. "*The models produced by Sevel* (SevelSud) *had identical technology, for example everything about the dashboard, the seats and the paneled. We can say that the three models was identical for a good 80%. The engines could be equal but generally, FIAT installed Fiat engines and PSA installed Peugeot and Citroen engines" (Accounting Manager, SevelSud)*. The performance of SevelSud and SevelNord are not comparable. In the next figure, we show the difference. We explore the comparative performance of SevelSud and SevelNord and on the FIAT and PSA models.

SevelSud total vehicle production



SevelNord total vehicle production

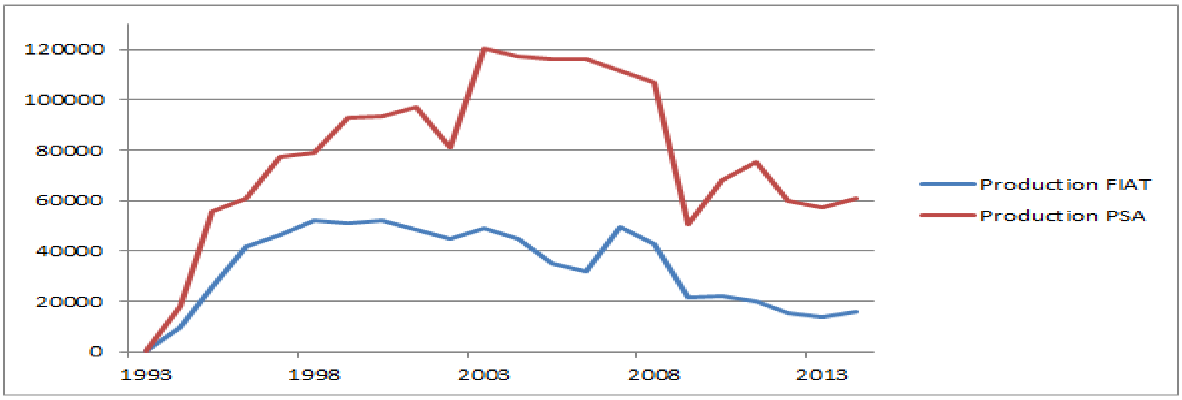


Figure 5: Total vehicles production

We observe that each site is specialized in its brand. SevelSud produces a majority of FIAT vehicles while SevelNord produces mainly PSA vehicles. SevelSud builds almost 140 000 vehicles while SevelNord maximum production culminates is 120 000. SevelSud is more productive than SevelNord as it constructs 106 000 PSA vehicles while SevelNord reaches the maximum of only 46 000 FIAT vehicles. These observations draw to the conclusion that SevelSud is more efficient. We also identify the effect of the 2008 crisis that entailed a collapse in production. However a rebound is perceptible in SevelSud and not in SevelNord, especially concerning FIAT vehicles production that falls under 20 000 vehicles.

In order to understand the difference in the performance and activity, we analyzed the model's success and we could identify a remarkable success of Fiat Ducato. The following figure shows that it represents the dominant vehicle in the portfolio of light vehicles.

4.3 Ducato as a Technological Standard, SevelSud Success and SevelNord Interruption

We observe the single production of Fiat Ducato, Peugeot J5 and Citroën C5 in the SevelSud site. This choice is justified by the fact that our interviews are made in SevelSud factory and because the Italian site is the only establishment in Europe, where Fiat Ducato is produced. Our data includes the horizon 1984 to 2012. The production is three times more important for Fiat Ducato **3.178.80)** as compared to Peugeot J5 and Peugeot Boxer (**1.098.829)** or Citroën C25 and Citroën Jumper (**951.796)**.

The Fiat Ducato appears to constitute an exceptional model for its dominance on the market and longevity. It can be considered a technological standard as it is associated with a dominant technology. Indeed, it was, also, sold as the Citroën C25, Peugeot J5 and Talbot Express for the first generation while the second and third generations commercialized as Fiat Ducato, Citroën Jumper and Peugeot Boxer. In Europe, it is produced only at the SevelSud factory, in Val di Sangro, Italy. It has also been produced at the Sevel factory in Sete Lagoas, Brazil, at the Karsan factory in Akçalar, Turkey, at the Lotus factory in Iran, at the Chrysler factory in Saltillo, Mexico, and at the Sollers factory in Elabuga, Russia. Since 1981, more than 2.6 million Fiat Ducato have been produced. The Ducato is the most common motorhome base used in Europe with around two thirds of motorhomes using the Ducato base (dominant technology). Thus, the Ducato is a technological standard in light vehicle sector that creates a dynamism on which SevelSud bases its performance.

Analyzing the technological aspect of this alliance, the design is the following: the conjunction of two innovations leads to MPV cars showing the following feature: a modular passenger cell with a large capacity for people (up to 7 or 8 seats) and/or luggage, tools or leisure equipment. At the first introduction of the MPV concept, few car manufacturers were confident in its development. The uncertainty was more related to the level of demand (a new concept) than to technological considerations. Coopetition between PSA and FIAT generated a market dominant technology for the light vehicle sector: Fiat Ducato.

The success of Fiat Ducato model is explained not only by the number of product sold but also by their role in the Light Vehicle sector: "*Fiat Ducato is the only model recognized by all in the European light vehicle sector with his original structure in the 1981 has revolutionized the way of transportation of goods for the workers. It dominates the European market but is also known in the other continents*". On this dominant standard basis, three motor generations are developed[4]: Finally, figure 4 resumes the implementation of technological standards in this alliance.

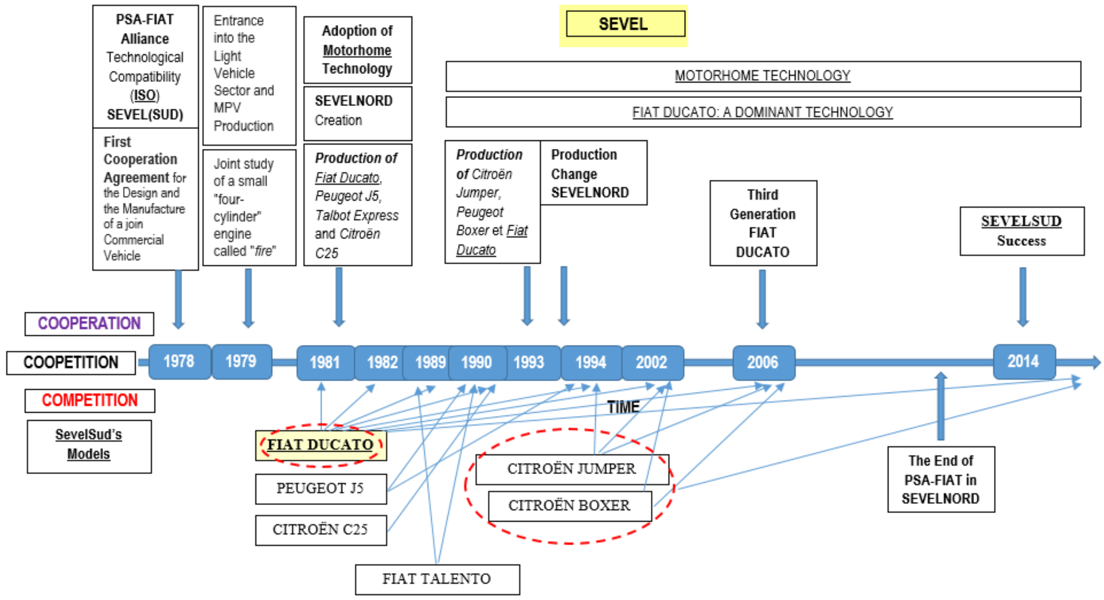


Figure 6: Time, coopetition and technology

[4] First generation: The Ducato was first launched in 1981 and was the result of Fiat's collaboration with PSA that resulted in the vehicle's development starting in 1978. The vehicles were manufactured at the SevelSud together with the similar Citroën C25 and Peugeot J5 versions. The Peugeot J5 sold as the Talbot Express in the United Kingdom (1986-1994). There are different models of Ducato. Model variants are: Ducato 10 (1.0 tons), Ducato 13 (1.3 tons), Ducato 14 (1.4 tons) and Ducato Maxi 18 (1.8 tons).
Second generation: In the second version, Peugeot called it Boxer while Citroën named it Jumper (Relay in the UK). The Ducato has four engines: the 2.0 petrol, 2.0 JTD, 2.3 JTD 16v or 2.8 JTD. All of these conformed to the Euro 3 standards and offered programmed maintenance management. The range included two types of gearbox: a mechanical box with a five-speed manual plus reverse and an automatic transmission with four speeds plus reverse.
Third generation: The third generation Jumper/Relay launched in May 2006, followed by the Boxer in June and the Ducato later that year. The vehicle was available in many variants both for people and goods transport. Now Ducato is: Ducato 30 (3 tonnes), Ducato 33 (3.3 tonnes), Ducato Maxi 35 (3.5 tonnes) and Ducato Maxi 40 (4 tonnes).

Considering the chronology, we show that the technology Ducato through its three generations enabled to the SevelSud JV to perform over time. In over words, the success of SevelSud as compared to the failure of SevelNord can be attributed for a large part to the exceptional success and longevity of the Ducato Technology.

5 Discussion

We conclude from the analysis that the longevity of the coopetitive alliance is due to its performance to market a dominant technology. The analysis shows how the alliance resisted to the tensions between competition and collaboration. The competitive part lies on the market, because the models, offering the same performances, are branded under different names. The cooperation is on the production side as they are built in the JV that associates the competences of the two firms. In spite of the competition between the models (Fiat Ducato vs Peugeot J5 and Citroen C25, 1981-1994) and (Fiat Ducato vs Citroën Jumper and Citroën Boxer, 1994- until now), the alliance resisted because all these models are based on the same technology. The technological collaborative advantage beneficiates to both producers and surpasses their rivalry. Soppe, Lechner and Dowling (2014) show that companies engaged in certain relationships coopetitive stop their alliance for three main reasons: high level of risk, implementation of alternative strategies and adopt divergent strategies. In some cases, companies avoid coopetition terminated because of the perceived risk and fear of negative consequences (Soppe *et al.*, 2014, p. 558). In other cases, some companies withdrawing from the collaboration once they have developed internal expertise or found more attractive business partners. In general, then, to find an alternative perceived as less risky leading to the cessation of coopetition (Soppe *et al.*, 2014). In the case that we analyzed, we do not observe this opportunistic behavior. Each manufacturer has a brand equity it wants to preserve and exploit. The prospect of coopetition in this case leads to the conclusion that instead of constituting a limit to the covenant, this situation is likely to bring more performance because the efforts of cooperation are multiplied by the competitive situation.

6 Conclusion

In this contribution, we aimed at identifying the role of standards in contributing to coopetitive alliance. Our idea was that alliance management especially in the situation of coopetition (alliance between rivals) would require a specific management of standards. The technological and relational compatibility in the coopetitive management has allowed the JV prosperity in the time. In fact, what emerged from our interviews was the importance of the performance expectations from the alliance and especially concerning the technology. The standardization effect is expected in the general sense as a technology diffused, shared and installed on the market. From this perspective, a major technology standard is identifiable all along the thirty-year alliance: Fiat Ducato. It plays a considerable part in the longevity of the alliance. The importance of this technology is observable on the creativity of the vehicle offered all beneficiating of this common technology. In addition, comparing the two sites alliances, the Italian site that is specialized in Ducato technology is prolonged sine die while the French site stopped in 2014.

Finally, technology standard, meaning a standard issued from the market competition, had major influence on alliance longevity than local standards issued from the firm. In other words, the role of standards appeared more clearly on the market side than on the organizational side. Technology standards were clearly identified as a manner to manage the performance risks associated with the alliance while interfirm local standards did not appear so important to manage relational risks of the alliance.

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Acquiring Legitimacy through Adoption and Diffusion of Standards

Jaykumar Padmanabhan, Ganesh Prabhu, Raghunath S

The Indian Institute of Management, Bangalore
jaykumar.padmanabhan@iimb.ernet.in

***Abstract**: In this paper, we argue that development of standards leads to a technological separation that necessitates specialization, reduced asset specificity & reduction in transaction costs thus leading to a process of disintegration in the industry. The empirical evidence for this is provided through two case studies. The first empirical evidence is the case study of "reverse outsourcing" done by Bharti Airtel, an Indian telecom operator. Telecom operators traditionally have preferred to have control over their networks because technology has a significant impact on quality of service. Bharti is an interesting example because it is the case of an operator that identified its core strengths as customer service and brand building and preferred to "outsource" non-core functions such as network maintenance to players from high-cost locations. We illustrate through the case study of the development of a VoIP standard the role played by the component production process in the diffusion of standards.*

1 Introduction

The Standards creation process is an incremental process with contributions from interrelated events rather than through emergence of a few discrete events (Van de Ven, 1993). Studies of innovations of network computing standards (Garud et al. 2002), Linux open standards (Tuomi, 2002) suggest that innovations in technology systems are often collective achievements. Actors involved in the innovation process contest from their own technological frames and have differing and conflicting interests (Van de Ven, 2005). As new components are added to existing layers of technology, the meaning of complex technology systems is shaped through a negotiation process. A standard is a socio-technical network where technological and non-technological elements are linked; which implies that the design process shapes the standard. Standards are not just neutral technological components but inter-organizational communication patterns as well as actions that has to take place locally in user organizations (Montiero and Hanseth, 1995).

Standards play a critical role in shaping markets by enhancing and constraining competition in information- intensive industries. Once players choose a particular standard, it is hard to change track and choose an alternate technology due to threats of lock-in or lock-out. A commitment down a technology path makes it difficult for the constituents to reverse their decision even if the decision is bad. Dangers of not participating in the process is sometimes equally devastating as a firm can be shut out of growth and profit opportunities as any attempt at subsequent change is expensive. Thus, threats of lock-in or lock-out have reinforced the role of standards in industries with network effects (Arthur, 2009).

Technological standards represent interface specifications and even "rules of engagement" that dictate how different components of technological systems work together (Garud and Kumaraswamy, 1993). Common standards offer a framework that enable users to evaluate and exchange products in the marketplace (Garud and Rappa, 1994). By designing the products to common standards one can achieve compatibility. Standards are able to detail the functionality of individual components and the rules of engagement among them because they are codified (Garud et al. 2002). Participation in standards can enable users to avoid technological dead-ends, avoid being stranded with an incompatible technology, reduce dependency on vendors, avoid lock-in onto a proprietary solution and leads to promotion of universality where different components are seamlessly interoperable (Jakobs, 2003). Under the assumptions of technological determinism all processes of production can consist of one or several inseparable entities, given the technological knowledge. Between these entities, technologically separable interfaces appear.

1.1 The role of modular architectures

We can identify technologically separable interfaces between operators, network equipment manufacturers, software providers and mobile handset manufacturers. During the infancy of the telecom industry the switching system designed using electromechanical principles gave rise to a single transaction between telecom operators and network equipment manufacturers with a high degree of asset specificity. The switching system then split into two different technologies entities with two different transaction characteristics: hardware and software. A new technological interface appeared as a result of this separation. With the separation of hardware and software, new transactions happened through upgrade of software. The introduction of new software provided a competitive advantage for first movers and the growing competition in the telecommunication services segment gave endogenous incentives to the separation of customer services from basic network administration (Denis Phan and Thierry Sommers, 1999).

This divided technical leadership, where some firms possess the capability to supply key components, makes new firm entry easier. An important feature of the telecom industry is rapid and sustained technical innovation. Technological innovation in VLSI (Very large scale Integrated Circuits) results in shrinking of components and the emergence of more modular systems and platforms with new opportunities for standardization. A platform is a bundle of standard components around which buyers and sellers co-ordinate efforts (Bresnahan and Greenstein, 1999). Platform compatibility, particularly a compatible standard between the hardware and software is valuable to business customers because of the sunk costs of adopting a platform. This further leads to decrease in asset specificity and an endogenous definition of new technologically separable entities. The modular architecture of modern telecommunication systems extends the separation between hardware and software through separation of the different network functions like signalling, network administration and service provisioning, from the transport of information. Through appropriate interfaces, the supply of services is made independent of the underlying infrastructure thereby increasing the modularity.

Telecom operators traditionally have preferred to have control over their networks because technology has a significant impact on quality of service. Bharti a telecom operator in India, is an interesting example because it is an operator that identified its core strengths as customer service and brand building and preferred to “outsource” non-core functions such as network maintenance to players from high cost locations (Raghunath, 2011). In the early part of the first decade network equipment manufacturers like Nokia, Siemens, Nortel began to outsource maintenance and operation of complete network elements to Indian software service providers like TCS, Wipro, Infosys, Sasken etc. This enabled them to reduce cost of maintaining and enhancing their network elements. British Telecom (BT) also formed a joint venture with Tech Mahindra for support of network operations like operations system and support and billing support systems. Also, standardization of interfaces between network elements and creation of standard software components reduced asset specificity of the elements.

1.2 Role of technology

Under the "semi-weak" form of technological determinism assumption, all processes of production can consist of one or several inseparable entities, given the technological knowledge. Between these entities, "technologically separable interfaces" appear. A transaction may thus be said to occur when goods or a service are transferred across a technologically separable interface (Williamson, 1981; Patibandla, 2006).

We can identify technologically separable interfaces between operators, network equipment manufacturers, software providers and mobile handset manufacturers. During the infancy of the telecom industry, the switching system designed using electromechanical principles gave rise to a single transaction between telecom operators and network equipment manufacturers with a high degree of asset specificity. The switching system then split into two different technologies entities with two different transaction characteristics: hardware and software. A new technological interface appeared as a result of this separation. With the separation of hardware and software, new transactions happened through upgrade of software. Introduction of new software provided competitive advantage for first movers and the growing competition in the telecommunication services segment gave endogenous incentives to the separation of customer services from basic network administration (Denis Phan and Thierry Sommers, 1999). Thus this divided technical leadership, where a number of firms possess the capability to supply key components makes new firm entry easier. This leads us to the following proposition

Proposition 1: The emergence of standards on average reduces information asymmetry, opportunism and hence reduces transaction costs

To test the first proposition, we use the case study method and consider the case of Bharti Airtel, an Indian telecom operator. The case study method enables the understanding of why a certain sequence of events happened or how a series of decisions was taken in an organization while facilitating a focus on contemporary events – thus facilitating the understanding of dynamics within a single setting (Yin, 2002; Eisenhardt, 1989).

2 Case study: Bharti Telecom

Bharti's founder, Sunil Bharti Mittal wanted to take advantage of the liberalization of the Indian telecom market. He placed a bid for license from the government to operate telecom services in the Indian capital region of New Delhi. Bharti won this order and launched a service using the GSM technology and named the company "Airtel". Bharti managed quarter on quarter increase in PAT & revenue growth (with a CAGR of close to 40%) for over 20 successive quarters with EBIDTA margins comparable to leading operators around the world. Bharti also shared towers sometimes even with competition. Bharti Infratel, Vodafone and Idea came together to set up a joint venture Indus towers to handle passive assets. All this helped Bharti Airtel to reduce transaction costs. To serve the increasing population of customers, India's telecom operators build infrastructure, expand capacity in high population centers through high cell densities. Airtel owns most of the regions that are marked for coverage known as "circles" in the Indian region. More than 75% operate above capacity. In 1999, Bharti sold a 20% equity interest to the private equity firm Warburg Pincus. In 2002, Bharti was listed publicly on the Indian stock exchanges. The capital infusion allowed Bharti to get mobile licenses for 15 out of India's 23 total circles and it became the first private service provider to launch national and international long-distance services.

The telecom industry worldwide is thought of as a high technology industry. Makers of network equipment work closely with operators to create and influence standards and roll out networks based on the most advanced technologies. Bharti's management team recognized that their core expertise was not in technology and the telecom business in India was at the end of the day a retail business. Bharti had to conserve capital to respond to the massive growth opportunity in its domestic market. Therefore the management team chose to outsource installation, service and maintenance of networks to Nokia, Ericsson and Siemens. This was considered highly unorthodox at that time as the order of the day was to control the technology and monitor vendors closely. It also chose to outsource the building and maintenance of its IT systems. IBM was chosen as a vendor for this purpose.

Bharti identified brand building and customer services as its core competence. The core activities performed by an operator like Bharti Airtel typically involves the provision of mobility. This involves the selling, activation and deactivation of SIM cards, tying up with third party valued added service providers to provide value added services. It also has to brand itself and ensure customer additions for growth and capacity utilization.

Bharti entered into outsourcing contracts with Network Equipment Vendors and software service providers. In March 2004, Bharti signed a deal with IBM for a 10-year partnership arrangement for an "on-demand" business transformation with payments based on a predetermined percentage of Bharti's revenues (Asis and Narayanan, 2007). In July 2004, Bharti signed the last of three successive deals with its telecom vendors arranging for the transfer of the build-up and management of its telecom network to vendors Ericsson, Nokia, and Siemens. The employees who were working on planning and designing the company network were transferred to NSN following the deal. Bharti outsourced network building, installation, maintenance to third party suppliers. The vendors for telecom equipment were paid only for the capacity utilized and not for the equipment (Asis and Narayanan, 2007).

Telecom carriers face challenges from device makers, demanding customers, increasing competition & disruptive technologies. The mobile telecom sector straddles the establishment of network infrastructure for the transmission of signals and the delivery of the service (telecom as well as various other value-added services). So, unlike most other sectors wherein firms would be engaged in either manufacturing activity or service provision, the telecom operators have to worry about establishing infrastructure with state of the art equipment and deliver high quality services.

The telecom software system is typically architected in a modular fashion. The switching control layer performs the functions needed for routing, changing paths or getting information from a database. The access layer enables users to establish connections by providing the customer with a friendly interface and is often the first layer in the overall experience. The access part of the networks forms a high cost of the customer equipment and is a large share of the network investment. The transport function plays the role of separating the traffic and often presents a channel between distant network nodes. Thus it establishes a path that enables routing and switching.

Due to relentless advancement in technology and increasing competition the dynamics of telecom industry are forever shifting. Carriers are constantly under pressure to upgrade their networks. For e.g. carriers like AT&T had to spend almost $18 Billion dollars to upgrade its wireless networks to handle new traffic. In addition several internet companies seriously threaten the position of these operators by offering free calls. While the operators have to make heavy investments in infrastructures many of these companies get a free ride on their infrastructure by using protocols that provide over the top services. This sets the context to examine Bharti's outsourcing decision that was considered as unique.

3 Discussion and Analysis

Traditionally operators have maintained control over their networks because the likelihood of holdups is high due to high asset specificity. A firm produces a component internally when asset specificity is high and internal component production costs are close to external component costs. When asset specificity is high the rate of change of transaction costs as a function of asset specificity is higher than the internal costs. High asset specificity increases the chances of holdups thereby increasing transaction costs. When standardization reduces asset specificity, external transaction costs fall more than internal transaction costs & transacting in the market become the preferred mode.

Another question of interest is the knowledge and asset intensity of Bharti's outsourcing partners viz NSN, Ericsson & IBM. As the asset specificity of the networks decrease & players like Huawei enter the market the network infrastructure services provided by these players will remain tradable assets. Similar arguments hold for services provided by IBM. They can be easily substituted by other software service providers. Hence, the chances of holdup have significantly reduced. Through this business model innovation Bharti managed to create a win-win situation for both suppliers and itself and was able to change the traditional governance mechanism of hierarchy to a market mechanism. The time to introduce new services was reduced and this form of governance enabled them to focus their management bandwidth on their core business aspects of customer service, branding and strategy-making. Bharti's service vendors called managed service providers found new revenue streams and offer bundled services i.e. both equipment and operations which would create a steady stream of revenues for them. Thus transaction costs were lowered as a result of technological separation between the elements of the network, hardware and software switching elements that led to specialization and reduced asset specificity.

Transaction costs and heterogeneity of capabilities jointly determine firm scope and boundaries; four evolutionary mechanisms drive the coevolution of transaction costs and capabilities (Jacobides and Winter, 2005). In the early stages of development of the industry service providers were involved in all aspects of traffic creation and handling. Bharti faced intense competition (selection process) in the domestic markets with severe pressures on ARPU (average revenue per user) as a result of competitors vying for market share. This led to Bharti trying to reshape the environment by outsourcing to its partners. There was increasing separation of activities related to market share creation, growth & infrastructure/technology related issues. Bharti then identified its capabilities as customer service and brand building. Thus the "first step" conditions were in place: capability heterogeneity which with transaction cost reduction leads to specialization. Maintenance of infrastructure and creation of software for billing and administration that was internally within the firm earlier was slowly substituted with services purchased from more efficient firms. This led to endogenous reduction in transaction costs. Thus it pioneered approach of "reverse-outsourcing". This process was later imitated by competitors. The industry as a whole was steered by Bharti towards greater use of the markets. The difference in culture, incentives and knowledge bases along the value chain made the combination of activities in a single firm problematic. Creating market share was about brand building and aggressive competition with other market players. The back end infrastructure on the other hand was about understanding and using technology. Thus the roster of new participants in the industry included IBM & the Network equipment manufacturers like Nokia Siemens & Ericsson.

Bharti Airtel's bold strategy has also produced outstanding results at the bottom line & resulted in external recognition. Bharti has been able to post high margins, better than the rest of the industry despite flat to declining ARPUs (Average Revenue per User). The company senior management mention that process efficiency and scalability as a big factor in its performance, the ability to bring activation from four days to two hours, and billing cycles from 15 days to two hours and the ability to handle more and more customers. Thus, Bharti was able to choose the market form of governance in an industry traditionally dominated by the hierarchical form of governance.

3.1 Coevolution of standards and new technology based firms

An important feature of the telecom industry is rapid and sustained technical innovation. Technological innovation in VLSI (Very Large Scale Integrated Circuits) results in shrinking of components and the emergence of more modular systems & platforms with new opportunities for standardization. A platform is a bundle of standard components around which buyers and sellers co-ordinate efforts (Bresnahan & Greenstein, 1999). Platform compatibility, particularly a compatible standard between the hardware and software is valuable to business customers because of the sunk costs of adopting a platform.

Two types of standards have been identified in the literature: anticipatory and participatory standards (Sherif, 2001). Anticipatory standards emerge at the early stages of the technology life cycles, specifying the concepts, features, components and tools of new technology while participatory standards follow in the later stages as performance improves trying to interconnect sets of disparate systems (Sherif, 2001). This further leads to decrease in asset specificity and an endogenous definition of new technologically separable entities.

The modular architecture of modern telecommunication systems is an example of how the separation between hardware and software has resulted in the separation of the different network functions like signalling, network administration, service provisioning from the transport of information. Through appropriate interfaces the supply of services is made independent of the underlying infrastructure thereby increasing the modularity.

Start-up firms suffer from the liability of smallness and newness (Stinchcombe, 1965; Suchman, 1995). To achieve growth firms need access to resources and capabilities. Hence, firms engage in the process of seeking and obtaining legitimacy in order to get access to resources needed for growth. Legitimacy has been viewed in the literature as a "perception that the actions of an entity are appropriate within a system of socially constructed norms and values" (Suchman, 1995; Lamin & Zaheer, 2012:48). This is very important for smaller firms that have to establish themselves and have to incur additional costs to overcome liabilities of smallness and newness. For new technology based firms to get social acceptance in a sociotechnical system the entrepreneurs or founders have to convince potential users of products, existing firms and industry champions. To combat this uncertainty, such firms may imitate the most prolific entity (DiMaggio & Powell, 1983). New technology ventures have to face varying demands from different set of stakeholders that lead to legitimacy issues (Uberbacher, 2014).

The diffusion of technology and adoption of standards can be viewed drawing on tenets of the Actor Network theory (ANT). The "actant" is any technical or social element that becomes a part of its network through its properties – behaviours and its interests (Akrich and Latour, 1992). Some examples are regulators, standard bodies, network equipment manufacturers, etc. Calon (1986) describes translation and inscription process in the creation of the actor network. The process of translation enrols allies into a stable and irreversible relationship while inscription refers to the way the artefacts embody the actors behaviour when they enter into a relationship with other actors in a network (Callon and Latour, 1981). Callon and Latour define overall conditions for network passage and expansion called obligatory passage points where technology and its relationships are taken for granted. The three realms of innovation, marketplace and the regulatory regime can be viewed as passage points for the actor network in the diffusion process (Lyytinen and King, 2002). An actor may also be a technological artefact like a standards body or an entity like the firm.

Start-up firms need "market legitimacy" to get access to main stream customers who will have doubts about the competencies of the new players. "Market legitimacy" determines the firm's ability to conduct business in a particular market (Dacin, Olivery and Roy, 2007). Market legitimacy is important for firms participating in the standards creation process because new competitive rules determine success in a standards based industry. There are several competing standards in the beginning of the technology life cycle in the industry. Historically the standards that have diffused are not necessarily the best standards and factors other than technological superiority play a vital role in a particular standard becoming the dominant one. However the cost of betting on a wrong standard can be catastrophic for a firm (Shapiro, Varian, 1999). The arguments made above lead to the following proposition.

Proposition 2: Information and knowledge dependence in a component production process leads to development of platforms and diffusion of standards. This process lends market legitimacy to new technology firms involved in this process.

This proposition is tested using the case study below.

4 Case Study 2: Diffusion of the SIP Standard

We trace the process of the creation of the SIP standard that has become a dominant VoIP standard used in both wireline and wireless networks. The journey of the evolution of the SIP standard had interesting features, such as the creation of technology block of firms to take on an existing standard that was backed by more established players and an established reputed standards body that had processes in place.

We studied the websites of the standard bodies SIP Forum, ITU-T, and firms that developed these standards and published research on the standards to develop this case study. The evolution of the SIP signalling standard shows how IETF (Internet Engineering Task Force), the standards body that develops standards related to Internet technologies employed a consensual approach in the development of the standard. Using the theoretical lenses described earlier, we can explain how the SIP standard prevailed despite the incumbent technology having the advantages of an installed base and first mover advantages, the key to successes in standard battles in the Shapiro Varian framework.

There had been an on-going battle over the signalling protocols that add call control to IP telephony. On the one side was H.323 an ITU standard and on the other side is SIP, a signalling protocol adopted in early 1999 by the Internet Engineering Task Force. The ITU (International Telecommunication Union) has historically been relied upon by the telecom industry to set international standards. Thus, the ITU has played a significant role starting with the telegraph in the 1860's through radio in the 1920's to the plethora of standards that exist today. The ITU Telecommunication Standardization Sector (ITU-T) which is a body of the ITU studies technical, operating and tariff questions and issues recommendations on them intending to standardize this on a worldwide basis. The technical work on standardization is done in ITU-T in study groups, producing draft recommendations that are approved by qualified members (Jakobs, 2003).

The Internet Engineering Task Force (IETF) is more informally organized and engaged primarily in the development and specification of Internet standards. The IETF largely works informally with no members, no board, and no membership fees. A lot of the technical work happens through posts and discussions in mailing lists which are open to anyone who wishes to contribute. Hence, companies such as HSS and Dynamicsoft were able to participate and actively contribute to the development of their standard. The tools and expertise developed earlier were used effectively to address the technology challenges.

H.323 was the first standard for video conferencing, created under the umbrella of ITU standards in 1996 and has been enhanced and augmented many times since. H.323 is overarching specification rather than a protocol and consists of other protocols such as H.225 that defines RAS signalling, call signalling, H.245 control signalling and RTP (Real Time Protocol). It defines how other protocols are used to create the desired service. The original design intent was to implement multimedia conferences on a local area network (LAN) with the facility to announce and advertise conferences so that interested parties could subscribe or register and participate in the conference (Schulzrinne and Rosenberg, 1998).

The Internet Engineering Task Force (IETF) sought to create a much simpler, yet powerful protocol that could be used for call set up and management in support of VoIP applications. A working group was formed, and the result of that effort was the development of the SIP, which was ratified by the IETF as RFC (Request for Comments) 2543 in 1999. The simpler standard meant a light weight protocol stack that suited a company like HSS. It could employ a small team and move quickly often in a matter of weeks to implement the features described in the RFC which is the IETF terminology for standard specification.

4.1 Evolution of signalling standards

SIP is a telecom signalling protocol that aids error handling, call setup, teardown, and signalling. Unlike H.323, SIP moves a lot of the work of call management and routing out among different parts of the network. It is used to request resources and find the destination party on the other network (Schulzrinne, Rosenberg, 1998).

The proponents of signalling standards were split into two camps: Telcordia, Level 3, Cisco and teams within Nortel Networks, represents the IETF camp. The ITU camp was represented by Ascend, Lucent, Siemens, and Microsoft. H.323 has had a first mover advantage in being the first standard out of the blocks, and many established players had already made heavy investments in technologies using this standard.

4.2 Resource endowments

The earlier VoIP products were mostly proprietary formats designed to bypass the toll structure of the Public Switched Telephone Network (PSTN). VoIP standards began to emerge to take advantage of the benefits to accrue from true internetworking without unwieldy protocol translation systems. There were many competing protocols being offered and deployed by numerous vendors. Currently, there are two signalling standards that are competing for dominance in the market place.

This is an interesting case of two standards with different design philosophies available for the market to choose from. H.323 had an early start, and there was a relatively large base of products implementing H.323 on the market. Customers and OEMs wanted a single protocol or standard that would work uniformly through their system. There are significant network effects present in this business. Operators and service providers would rather do away with all the effort and patches they have to put in their software to deal with multiple protocols that don’t talk to each other.

SIP being a light weight standard was able to adapt quickly to the changes that were taking place as a result of the convergence of mobile, the internet and the computing standards. SIP was a lighter protocol and hence faster than H.323. Procedures were added to enable H.323 to connect basic calls much quicker to counter this obvious weakness in H.323. This procedure is referred to as "Fast Start". Fast Start eliminates several of the messages by requiring each side to have detailed knowledge of the parameters for the call and to have pre-assigned ports for communicating. The users development cost should be lower with SIP, since there is less code to develop at the application level. For carrier class equipment, less memory and less powerful CPU also means lower power required, which translates to lower cooling costs at the central office, a major design consideration for carriers (Schulzrinne and Rosenberg, 1998).

Both protocols allow for extensions, but SIP is much more extensible and includes functions specifically designed to enable easy extensions. Users can also add their own extensions to both, but to do so in H.323 requires the user to create extensions in ASN.1 format. The user using text messages, which are much easier to develop, can extend SIP and implement. H.323 elements must all maintain state information, whereas in SIP only the UA is required to do so. This further complicates the H.323 code in each element, and also increases the amount of dynamic memory needed in H.323 implementations. Both protocols support a robust set of telephony features.

In the “innovation” realm, standards represent the enrolment of actors behind one technological alternative. The proponents of signalling standards were split into two camps: Telcordia, Level 3, Sonus Networks, Cisco and teams within Nortel Networks, represented the IETF camp. Apart from Dynamicsoft that played a critical role in the development of the standard, other small start-ups also played a role in the standard development, Vovida (later acquired by Cisco) and India based HSS.

The ITU camp represented by Ascend, Lucent, Siemens, and Microsoft had a first mover advantage in being the first standard out of the blocks. Only some of the alternative innovations become standardized when specific connections are created between certain technological features and some of the actors mentioned above in the network. This happens when a new feature such as “Fast Start” is introduced or new capabilities that utilize these interfaces are agreed and written down as technical specifications.

Being a lightweight standard, many start-up companies emerged that worked on developing the standards. Modifications in the standard to accelerate changes in technology happened because of the flexibility of IETF and its ability to respond faster to the need to interoperate with the mobile networks. Ultimately the adoption of SIP by 3GPP the standard making body for 3G networks signalled the winner. As the requirements increased with changes in technology, features began to get added to the standard, the processes and the evolution of the standard was influenced by the speed of response by the standards groups.

Thus, the evolutionary processes of variation, selection and retention are able to explain the emergence of the SIP standard. The routines adopted by the ITU to evolve its standard were elaborate long cycles of deliberation, debate and approval. IETF, on the other hand adopted routines that consisted of collation of comments posted online, filtering followed by quick resolution of issues and a forum that facilitated transparency

4.3 The realm of marketplace

The realm of marketplace refers to the diffusion cycle that covers the willingness and propensity of actors to adopt the new technologies and standards. Success in a standard based industry requires new competitive rules. Often these new technologies are introduced through new firms rather than established firms, and if the new technologies become dominant, then these new firms emerge as market leaders rather than the old firms, much like the evolutionary process of selection and mutation. The concept of marketplace also involves understanding changes in consumer behaviour as a response of introducing new technologies and services. In the 1990's, several factors combined to create an environment conducive to the development of voice over packet networks. We describe these factors in terms of resource endowments that are critical to technological innovations.

One of the major resource endowments was in the form of research advancements in the telecommunications and networking and availability of increased bandwidth. QoS requirements and the need for ease of operation and functionality for the end user require the IP Telephony architecture to provide a signalling infrastructure that offers, at least, the same capabilities and features as the Signalling System 7 (SS7) architecture in PSTN. Signalling must make the telephone calling process transparent so that the callers need not know what technology is actually implementing the service. The signalling infrastructure must be scalable in terms of supporting a large number of registered endpoints, supporting a large number of simultaneous calls, be extensible regarding adding new features easily and supporting interoperability among different vendor implementations and signalling protocols.

4.4 The regulatory regime

The regulatory regime refers to any authority that can direct, prohibit an activity, impose constraints on how the activity can be organized. Regulatory interventions can refer to licensing decisions or decisions on allowing certain features in protocols. Let us view the implications of the regulatory regime in our case study.

The IETF and the ITU have, historically, taken very different approaches to the development of protocol specifications. The ITU approach of including as much as possible in the specification and to anticipate anything everyone would ever want to do and results in a long cycle of specification development (several years is typical). That is and is also why H.323 is very large. It has many procedures to support esoteric elements that are rarely (if ever) used in VoIP applications.

The IETF, on the other hand, has an "RFC" (Request for Comments) approach to standards creation. A document is developed and posted on the relevant group for comments. On the plus side, this approach allows the protocol to be developed and published much quicker than ITU documents, and also results in protocols that are much smaller in code size, once implemented. Thus, the IETF adopts a community of practise approach to standards creation. The IETF approach allowed small start-up firms like Dynamicsoft, Vovida and Hughes software to create lightweight protocol stacks based on the SIP standard that could be used in interoperability testing by the operators and OEMs. This, in turn, allowed expansion of the standard and the development of the products. To summarize, we have seen how the creation of a standard involves interactions between the main actors, a complex process of technical and social negotiation. The actor network continues to evolve with the evolution of the standard. In the next section, we consider an alternate perspective.

4.5 Community of Practice

The standard creation process described above can be viewed from a community of practice perspective. Standards creation is an incremental process with contributions from interrelated events rather than through emergence of a few discrete events (Van de Ven, 1993). Prior literature has explained the emergence of standards and innovation in terms of a community with three major components that include resource endowments, incentives for proprietary functions and institutional arrangements (Van de Ven, 2005). Three core elements: 'mutual engagement', 'joint enterprise' and 'shared repertoire' have been describe in the community of practise perspective (Wenger, 1998).

4.6 Mutual engagement

The SIP forum provided a forum for conducting basic research events, financing events and training events at the beginning of the standards creation process. These research events provided the knowledge underlying standardization and commercialization of the standard. A pool of competent resources is essential for the emergence of innovations and can be developed through education and training or through a network of practitioners (Van de Ven, 1993). The companies that worked to develop the standard, Cisco, Dynamic soft, Nortel organized research events and initial training events. This helped create Wenger's (1998) mutual engagement that helps members establish norms and rules of engagement and created a sense of "SIP" community.

The ITU Telecommunication Standardization Sector (ITU-T), a body of the ITU studies technical, operating and tariff questions and issues recommendations on them intending to standardize this on a worldwide basis (Jacobs, 2003). The IETF, on the other hand, is a more informal body with no formal board and with its proceedings co-ordinated through mailing lists.

4.7 Joint enterprise

In the next steps actions are taken to appropriate knowledge and transform it into proprietary knowledge. Wenger describes this as a joint enterprise where there is a shared understanding of what binds them together. Events are undertaken to find if a commercialized innovation performs in the desired manner. Activities are undertaken that transform the standard into interfaces that are compatible with other devices. Also, there is an aspect of promotion, sale and distribution of products associated with the standard. In the evolution of the standard, companies such as Sonus Networks, Dynamicsoft, Vovida and Hughes software systems developed components and participated in "Bake off" events that helped the development of the standard. (the term bake-off is no longer used because of a lawsuit). Though IETF promoted the SIP standard, the actual SIP standard development happened through a special interest group called the SIP Forum, which made it easy to integrate this work with other areas on the internet.

4.8 Shared Repertoire

These consist of activities undertaken to publish, support and legitimate product innovations. Typical events are legitimation events, regulation events and technology standards events.

Researchers have also studied how different industries in different eras are associated with different dominant technologies and how introduction of new technologies while initially inferior become competitive later. Often these new technologies are introduced through new firms rather than established firms and if the new technologies becomes dominant then these new firms emerge as market leaders rather than the old firms, much like the evolutionary process of selection and mutation. This has spurred research in dynamic capabilities and evolution.

Testing and evaluation events are one of the proprietary functions within the community and a way for firms to acquire knowledge. These events played an important part in taking SIP into the "Channel Creation" phase. Testing and evaluation events are undertaken by companies to find out if the commercialized product performs in a desired manner. This phase is the joint enterprise phase in Wenger's Communities of Practise terminology. The SIP interoperability events arranged 4 times a year provided an opportunity for HSS to interact with giant companies such as Cisco, Nortel and startups like Dynamic soft and Vovida Systems (later acquired by Cisco). The smaller companies played a key role in organizing these events, developing complementary products and cross platform tools. The SiPit was an informal gathering of engineers to test interoperability and robustness of products and prototypes with on-site debugging with the aim of improving implementation and the standard specifications.

5 Summary of Findings

A startup firm also faces isomorphic pressures for conformance as rational actors tend to make them similar to established organizations. The effort to achieve rationality with uncertainty and constraint leads to organizational isomorphism (DiMaggio and Powell, 1983). For small enterprises and startup firms, participating in standard committees is an important step in their evolution. Cooperating with larger companies enables them to access development activities and substitute their research and development efforts (Blind and Mangelsdorf, 2013).

The evolution of the SIP standard followed a complex process of technical and social negotiation. Using the analytical lens of Actor Network Theory we viewed the process of negotiation, the alignment of interest and the regulation and creation of markets. Actor networks provide a perspective that considers both the technical and the social angles in a sociotechnical process. The analysis identified the points of passage shaping the creation and evolution of the SIP standard, which did not follow a typical linear path but which involved a host of actors and events. The standardization process is inherently fragile and politicized, due to the simultaneous presence of elements of competition and collaboration in the actors. The case study illustrates how creating a new rival ecosystem is fraught with challenges.

Successful enforcement of standards requires more than just technological innovation or being a first-mover in a market. Participation in standardization processes, however, remains an integral part of product development and marketing strategies. The competitive strategies of new start-up firms must provide a broader network of complementary products which increases installed base and reinforces switching costs. Thus, startup firms with complementary capabilities play an important role in the development of standards and gain legitimacy once a dominant standard emerges. During the standards development process, different events within the community can evolve in different ways. Some of the manufacturing and marketing events outpaced some aspects of the resource endowments (e.g. training and education) events and some institutional arrangements. Since each actor from each part of the technological community influences every other part gaps or breakdowns have a snowball effect in causing breakdowns in the other community events.

6 Conclusion and Discussion

One implication of our study for technology entrepreneurs is that evolution of technology and standards happen when interests of different actors are aligned. Enrolment of actors in the network is essential for social construction. Aligning the interest of different actors in the network presents a significant opportunity for entrepreneurs and start-up companies to make a contribution. Another opportunity for start-ups is to provide services that enable new solutions or new uses for products designed by OEMs around existing standards. This type of service known as “adapting” service facilitates the integration of the core product built with an earlier standard to newer standards (Cusumano, Kahl, Suarez, 2015). In the case presented in the paper start-up companies such as HSS and Vovida built adapters that enabled customers who were rooted in their own standard to interwork with each other. The patterns of adoption are affected by regulatory issues, availability of features, technology availability and ease of use. In the paper, we saw how a solution devised for signalling standards became the dominant standard displacing the incumbent even though by all accounts, the incumbent standard had advantages associated with installed base, support from existing customers and the backing of a big standards body.

The lenses through which we viewed the case reemphasize that having the right allies aids the creation of a more valuable offering, attracts more customers and therefore 'tip' the war to its benefit. Our study suggests that the success of the SIP standard cannot be explained merely by looking at the three realms of ANT. While all these realms partially explain the success we need to understand the ways in which the actor network was configured. We, therefore, considered the Communities of Practise perspective which emphasized the creation of identity defined by a shared domain of interest. Creation of the SIP Forum implied a commitment to the domain and, therefore, a shared competence that helps give a unique identity. The members of this forum engaged in joint activities and discussions, building relationships that helped them learn from each other. The interactions on the newsgroups and the participation in interoperability events were essential in creating a feeling of community. This, in turn, helped them develop a shared repertoire of experiences, stories and ways of addressing recurring problems. The smaller companies that participated in these events played a key role in organizing these events, developing complementary products, tools to test and check the interoperability of products and often tools to bridge products that used the competing standards. The importance of these small players can be ascertained by the fact that the smaller players in the technology block, Vovida, Dynamicsoft were later acquired by Cisco at a significant price to sales multiples.

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Major European Research Contributions for Standardisation

Dr. Aikaterini Poustourli

Technological Educational Institute of Central Macedonia, Serres – Greece,
pkate@teiser.gr

Abstract: *This paper summarizes the status of selected and current European Research initiatives for standardization and standards of various scientific fields and in particular in Directorate General of Joint Research Center. A reference to the European Standardization System's structure and to the way of how standards are included in the EU projects and supplementary data for European innovation are set out comprehensively. The major contribution of the JRC institutions in the European and international standardization community is demonstrated by the overabundance of its dedicated research programmes for pre- and co -normative research projects. The Joint Initiatives for Standardisation is welcomed positively by the European shareholders and its future effectiveness is considered that can benefit the EU by a careful consideration of the modernization of the European Standardization System.*

Keywords: *Standardisation, Research, Innovation, European Union, European Commission, Joint Research Center (JRC), European Standardisation System (ESS), European Standardisation Organisations (ESOs).*

1 Introduction

The key role of standardisation as a bridge between research, innovation and markets has been recognised in recent political initiatives by all of the EU institutions. At a time when Europe needs more innovation in order to remain competitive at global level, standardisation can connect research and innovation with the market, and contribute to achieving the goals of the Europe 2020, Europe 2030 and Europe 2050 strategy in terms of smart, sustainable and inclusive growth. This fact sheet seeks to improve the mutual awareness and collaboration between standardisation on the one side and the research communities and innovators on the other. One of the most important things is the participation and contribution of researchers to standardisation without losing the opportunity to exploit their research outcomes through other channels. This paper is a brief overview of the relevant data that have been part of the author's scope of research and study during her assignment as a detached expert in the DG JRC the period of 2014-2016.

1.1 European Standardisation System (ESS)

By 2020 under the framework of global competitive continuous improvement and standard dynamics, the ESS will deliver a standardization system for Europe capable of meeting the needs of business, society and public authorities and of responding to the rapidly changing needs of the world, including the development and convergence of technologies, the improvement of product safety and welfare for citizens, and the challenges of climate change and energy management. The substantial quantified financial benefits of standardization will have been maintained and enhanced. Through its close connections to Member States and to the wider international standardization system, the ESS will be an effective centre of influence ensuring market relevance, avoidance of duplication and a proven added value of standardization. The ESS will be characterized by close cooperation between the ESOs, fora and consortia and their stakeholders. Key stakeholders, SMEs, larger businesses, societal representatives and policymakers will all be engaged in an effective, efficient and coordinated system for standardization, fit to support both the societal and economic needs of Europe and able to ensure innovation, growth and competitiveness for Europe in the world. The three recognised European Standards Organisations which constitute the ESS and they called ESOs (European Standardisation Organisations) are:

- CEN (the European Committee for Standardization),
- CENELEC (the European Committee for Electro-technical Standardization), and
- ETSI (the European Telecommunications Standards Institute).

In most cases, the initiative to develop a new standard is taken by interested stakeholders who consider that a particular standard would be useful as a way to address specific needs. Other interested parties then join the standardisation activities at national, international or European levels. In this process, companies, academic experts, researchers, SMEs, consumers and regulators bring together their ideas and experience concerning products, materials, processes or services in order to agree upon and produce a standard.

Standards are thus drafted by experts in the specific field covered by the standard. The CEN or CENELEC role is to facilitate, control and guarantee this process. Both organisations publish a range of documents: European Standards (ENs), Technical Reports (TRs), Technical Specifications (TSs) and Workshop Agreements (CWAs). European Standards (ENs) are settled in Technical Committees (TCs), composed by representatives of national delegations. The development process includes a public consultation period (national enquiry) before standards are voted by the CEN or CENELEC national members. The production of an EN may take up to 3 years. Thereafter, ENs have to be implemented by the CEN or CENELEC national members as a national standard with the consequent withdrawal of any conflicting national standards.Other deliverables from the standardisation process are Technical Reports (TRs), Technical Specifications (TSs) and CEN or CENELEC Workshop Agreements (CWAs); these deliverables have not gone through a national enquiry process and do not require to be implemented as national standards. The consensus and approval processes are here quicker than for ENs, with delivery times of less than 2 years for a TR or TS and possibly less than one year for a CWA. While TRs and TSs are developed in TCs under the national delegation principle, CWAs are developed in consensus working groups (called CEN or CENELEC Workshops) which are open to the direct participation of any interested party. CEN and CENELEC collaborate with their international counterparts ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) through the respectively Vienna and Dresden Agreements. The aim is to coordinate the standardisation work between the European and international level and to optimise the use of available resources and expertise for the benefit of stakeholders active at both the European and international level.

1.2 Including a standards action in EU projects

CEN and CENELEC promote an "Integrated Approach between Research, Innovation and Standardisation". In this vision, standardisation is not an afterthought of a research or innovation project but should be considered right from the start. Already at the project definition stage, it is important to know whether any standards exist that are relevant to a certain research domain. This is because standards codify the state of the art and promote the use of recognised methodologies, processes or terminology; as a result one can avoid reinventing the wheel. If there is no published standard that fully meets the needs of the project proposers and where a standard would bring value to the project in the context of the exploitation of the research results, a research consortium might decide either to develop new standardisation activities, or to contribute to on-going standardisation work. Identified standardisation needs can be included as an activity of the project proposal. Within the CEN-CENELEC Management Centre, a dedicated team informs and supports the research community in understanding and integrating standardisation in their future R&D project, through appropriate tools, such as web pages and a Research Helpdesk. The team provides tailored advice to project consortia, informing them of already relevant standards work, and helping them put together new projects for standards on innovative products.

Considering that there is no obligation to implement Technical Specifications (TSs) or CEN-CENELEC Workshop Agreements (CWAs) as a national standard and in view of their speed in production, TSs and CWAs may be preferred in situations where technologies have not yet reached a sufficient level of maturity, which will probably be the case where the technology directly originates from an on-going research project. Because of their nature they can be considered as stepping stones to ENs. More specifically, while they can be delivered for a technology which is at the experimental stage, and therefore not yet marketable, once the technology is mature for the market then it is possible to upgrade to the EN. The development of a CWA can be part of the project's dissemination package and it is normally possible to deliver it within the project's timeframe. To meet the requirements of European research projects whose scope closely corresponds with already on-going standardisation activities, CEN and CENELEC have extended in CEN-CENELEC Guide 25 the concept of liaison organisations to also cover European research projects. When so decided, representatives of the projects are allowed to participate in the relevant Technical Committee and Working Group meetings as observers. The consortia's participation is without decision power, but they will have the possibility to directly explore with the Technical Committee the standardisation potential of its outcomes. Moreover the CEN-CENELEC Guide 30 contributes for a better regulation through standards as guidance for policy makers. As underlined by Europe 2020 and the associated Flagship Initiatives, standardisation has a key role to play in stimulating innovation in the European Union and fostering European competitiveness worldwide. However, it will only succeed in doing so if the European Standardisation System (ESS) – organised around the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI) – can effectively *keep pace* with research, technological development and innovation.

A major initiative was funded under the 6th EU Framework Programme in order to find out some patterns which could inform and accelerate the development of standards in the future. Entitled NO REST, this initiative focused on the ICT sector and offers an interesting perspective given the infrastructure and interoperability related issues which are associated with this sector. Based on the analysis of NO REST, standards are depicted as inherent to technology and market developments and therefore to be dynamic by nature. Standards maintenance, standards succession and standards adaptation are identified as the three main types of dynamics. Standards maintenance relates to the revision of standards through technical amendments, mergers, split-ups or withdrawals. At this stage, the nature of changes is incremental. In the case of standards succession, standards are abandoned to be replaced by new standards in response to radical technological evolutions. Changes are not caused by incremental earning but by novelty and are of a radical nature. With standards adaptation, changes occur during the implementation phase. For instance, standards' specifications have to be revised to allow for an extension of its implementation or a partial implementation. The particular nature of standards dynamics is technology-specific and depends on the pace at which technologies, and their applications, change. It is also affected by four main factors which are the technology development, the market environment, regulatory changes and the characteristics of the standards setting body. The technology development can affect standards dynamics in a direct way, for instance when the technology embedded in the standards has improved, or in an indirect way, when standards are applied to new areas. The market environment is more or less supportive, depending on the level of interest showed by market players in a given standard. Regulatory changes can also be a significant factor. For instance, the change in radio frequency bandwidth had a significant impact on standards development. The characteristics of the standards setting body also have some consequences for standards dynamics. Standards which are originally of poor quality and difficult to implement are highly likely to undergo early changes.

In the context of emerging technologies and emerging industries, as highlighted by Sherif (2001) in the sectors of telecommunications and information technology, standards will inevitably be subject to change. Stable and incrementally changing standards reduce market uncertainty, but may not support radical innovation in an optimal way. Progress and innovation are associated with responsive standards. Consequently there is a dilemma between "stable" standards and "responsive" standards. From a practical perspective, the ways in which the negative impact of standards dynamics could be alleviated are being explored and a distinction is made between unnecessary and necessary dynamics. On one hand, in order to avoid any unnecessary dynamics, the quality of standards, and therefore the quality of the standards process, needs to be improved as an improved process is expected to allow for the development of more stable and less disruptive standards. On the other hand, keeping pace with technology evolution represents a "desirable" change which has to be facilitated. Two complementary strategies are put forward by the literature: the design of original standards permitting certain flexibility and the prioritisation of downward compatibility (or grafting). The impact of standards dynamics depends to a large extent on whether or not individual standards are compatible (NO-REST, 2005a). The grafting approach is deemed all the more sensible given the incremental, rather than radical, nature of most of the changes standards undergo.

2 EU 2020, Standardisation and Innovation

2.1 Standardisation and Innovation

In its 2011 Communication on '*A Strategic Vision for European Standards*', the European Commission identified the acceleration of the standardisation process as a necessary condition to achieve that objective, and underlined the potential of anticipation and foresight studies to identify in a more timely manner the needs for standards development. There will be a globalised economy serving an informed and prosperous global middle class that will require personalised goods and services based on advanced, ICT-enabled manufacturing systems supplied by European resource-efficient and sustainable industries.

2.1.1 Recognition of scientific involvement in standardisation activities

To encourage scientific involvement in the standardisation process, incentives need to be developed. This can be done in a similar manner to scientists gaining recognition for publishing peer-reviewed papers. In reviewing proposals for funding, for example, the scientists' involvement in standardisation activities should be taken into account as a key part of the evaluation criteria, based, perhaps, on dedicated indicators. In any case, the ESOs and the European Commission must be more proactive to attract researchers' interest in standardisation activities (e.g. when funding research programmes).

2.1.2 Dedicated research programmes for pre- and co -normative research

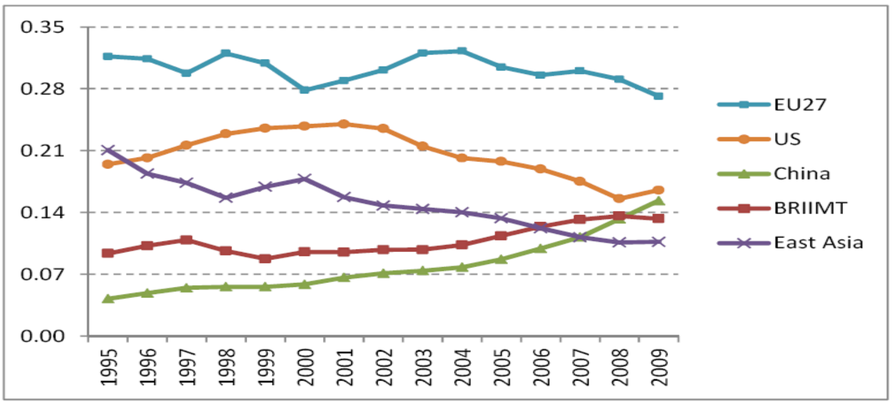
Standards are often based on pre-normative research. Their preparation often depends on peri- or co-normative research. To facilitate this, dedicated research programmes should be put in place which address preparatory research and the development of test methods and measurements, and are coordinated strictly with European standardisation planning.

2.1.3 Coordinated approach to research-supporting standards

In the research domain, European activity to support standards has to be coordinated to ensure a complete and coherent approach. Various groupings already exist, such as CEN-CENELEC's Standardisation, Innovation and Research (STAIR), to oversee the integration of standardisation in research projects. However, this effort should be strengthened to ensure European-wide coordination and action. In addition, a more systematic approach needs to be applied to harvest the results of European research programmes to support standardization. As such actions could be Integrating European efforts in standardization, Developing an international standardisation strategy for Europe, Integrating standardisation efforts to address complex cross-cutting issues, Engaging more stakeholders in standardisation, Engaging consumers and private citizens directly, Engaging SMEs through new incentives, Ensuring closer coordination with the European Patent Office, Communicating on standards, Standardisation awareness, Standards dissemination, Educating on standards etc.

2.1.4 The aspect of innovation

European Union is one of the world's best-performers in producing high-quality science and innovative products. It captures the largest share (28%) of income generated in global manufacturing value chains - the US and Japan shares are shrinking. Europe still the top destination of foreign R&D investments by US firms and its innovation performance is catching up with US and Japan, but China and South Korea are advancing even faster. In the following diagram 1, is pictured the Global value chain income for the period 1995-2009 (Kyle Gal, 2013*)*.



Note: East Asia includes Japan, South Korea and Taiwan. BRIIMT includes Brazil, Russia, India, Indonesia, Mexico and Turkey. EU27 includes all European countries that have joined the European Union. "Other" includes all other countries in the world. World GVC income is equal to world expenditures on manufacturing products at basic prices.

Fig. 1. Global value chain income for the period 1995-2009

Moreover, the total R&D budget of the 27 EU Member States increased nominally by 10% between 2007 and 2011. The most Member States acknowledged the importance of a smart fiscal consolidation. Business EU R&D expenditure is 10% higher in 2011 than before the crisis (2007) in nominal terms. The top R&D investing companies headquartered in the EU expect their global R&D investments to grow by an average of 4% annually over the period 2012 to 2014. EU R&D intensity grew from 1.85% of GDP before the crisis (2007) to 2.03% of GDP in 2011 (the EU had set a goal for members to spend 3% of GDP on R&D by 2020). Furthermore in the following figure we see the difference in percentage points between growth in Government budgets for R&D and real growth in GDP for the period 2008-2012.

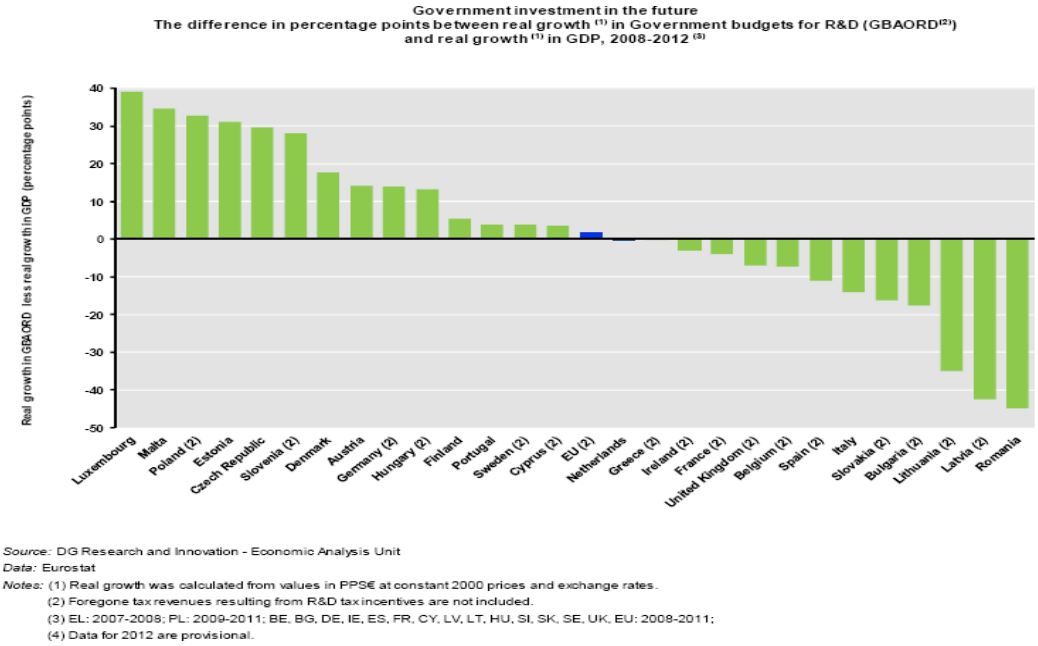


Fig. 2. The difference in percentage points between growth in Government budgets for R&D and real growth in GDP.

European Research, and more specifically the creation of a European Research Area, are now high on the policy agenda in Europe. Conducting European research policies and implementing European research programmes is in the first instance a legal and political obligation resulting from the Amsterdam Treaty. The Treaty does in fact include a whole chapter on research and technologial development (RTD), so as to underline that RTD is an essential element in the functioning of industrialised countries, such as EU Member States: the competitiveness of companies and the employment they can provide depend to a great extent on RTD; and RTD is also essential for the support of other policies such as consumer protection of the environment. In short: the individual and collective wellbeing of citizens depends on the quality and relevance of RTD.

But Europe must also play an activate role in RTD because of a number of developments inherent to the RTD sector itself

- high level research is increasingly complex and interdisciplinary;
- high level research is increasingly costly;
- high level research requests a constantly increasing "critical mass".

Hardly any research team or research laboratory, hardly any company can reasonably claim to be able to respond to these challenges. Even entire Member States find it increasingly difficult to be active and play a leading role in the many important areas of scientific and technological advance.

Organising co-operation at different levels, co-ordinating national or European policies, networking teams and increasing the mobility of individuals and ideas is therefore a requirement resulting from the development of modern research in a global environment. Without determined actions at European level the present fragmentation of Europe's efforts cannot be overcome. Taking up this challenge the European Commission, Member States and the European Parliament, the scientific community and industry are now committed to work jointly towards the creation of a "European Research Area" (ERA).

2.1.5 The aspect of human factor

The characteristics and experience of effective standardisation leaders is a repeated theme raised by many experts during the realization of the stakeholders workshops was the often critical role of key individual leaders in bringing emerging technology stakeholder communities together to address standardisation needs. There appears to be significant added value in identifying and supporting standardisation leaders (e.g. committee chairs, coordination initiative leads, etc) who have both the passion and energy to drive the process forward as well as the background, experience and skills that ensure the trust of all stakeholders while consensus on standards is being built. There also seems to be evidence those individuals with different types of backgrounds and expertise may prove more appropriate and impactful for different types of initiative and at different stages of an emerging technologies lifecycle. There may be value in better understanding evolving roles and functions of leaders at different stages in the emergence of a new technology, in particular what background, experience, expertise may be important.

Standardisation is considered as another core activity of researchers. Aikaterini Zi and Knut Blind (2015), in their paper entitled “Researchers’ participation in standardisation: a case study from a public research institute in Germany” are higlited that the latter has not been adequately taken into account. Assuming that publishing and patenting activities have an influence on researchers’ involvement in standardisation we seek evidence based on objective publishing, patenting and standardisation data. Based on their research on individual data of more than 600 researchers from the BAM Federal Institute for Materials Research and Testing in Germany, they performed multivariate regression analyses to determine the characteristics that influence researchers’ participation in standardisation at different levels. The estimation results showed a negative relationship between high quality scientific publications productivity and participation in standardisation committees and a positive relationship between technical and industry-oriented publications productivity and standardisation activities. Patenting and standardisation activities appeared to be contradictory only in a few model specifications. Academic qualifications of the researchers have a positive and statistically significant impact on the probability of participating in standardisation committees.

2.2 The Directorate-General Joint Research Center (DG JRC)

As the European Commission’s in-house science and knowledge service, the Directorate-General Joint Research Centre’s (JRC) mission is to support EU policies with independent evidence throughout the whole policy cycle. Working in close cooperation with almost all policy Directorates-General, DG JRC tackles the main societal challenges, stimulates innovation through developing new methods, tools and standards, and shares its know-how with the Member States, the scientific community and international partners. Moreover the establishment and management of a vast network of thematic groups who are respective to the JRC research and scientific areas and staffed by internal and external experts is supporting the above mission. The main economic sectors which are active and contribute to the Standardisation are:

2.2.1 Energy Security

The JRC acts as a reference body for the fuel cells and hydrogen Joint Undertaking, an industry-led public-private partnership, which brings together organisations from the EU, the US and Japan and feeds into European and international standardization and regulatory bodies. JRC also developed analytical and modelling tools for market and techno-economic evaluation of energy storage. In addition, contributes to the roll-out of smart grids through work on the safety (stability) and security of smart grids, as well as international standardisation. JRC together with the US Department of Energy (DoE) are establishing electric vehicle smart grid interoperability centres at the Argonne National Laboratory (inaugurated in July 2013) and at the JRC premises in Italy. Since early 2013, JRC have been carrying out the 'sustainable product policy" pilot project, in which contribute to the standardisation of products under the frame of the eco-design and energy labelling Directives. New players are entering in the fields surveyed. Energy grids need to interoperate with local communities. Innovation is increasingly distributed with active engagement by these communities. This raises new issues for European standardisation and innovation.

Furthermore projects like European Reference Network for Critical Infrastructure Protection (ERNCIP) providing a framework within experimental facilities and laboratories can share knowledge and expertise in order to better align test protocols throughout Europe, leading to better protection of critical infrastructures against all types of threats and hazards. Under its mission in order to foster the emergence of innovative, qualified, efficient and competitive security solutions, through the networking of European experimental capabilities, ERNCIP established and facilitated twelve thematic groups of respective thematic areas producing a large number of pre-normative reports. Involving different combinations of stakeholders at different phases of technology and industry lifecycles ERNCIP managed to organize operators' workshops which convene the right mix of stakeholders to support awareness, alignment and consensus building at the right phases of CIP cycle.

2.2.2 Enterprise and Industry

JRC support to this policy area is characterised by the wide range of topics addressed, covering almost all of the European Commission's enterprise and industry-related activities. Key areas of collaboration include clean transport; construction; chemicals, including REACH legislation; sustainable product policy; advanced manufacturing and Key Enabling Technologies; nanomaterials; standardisation; space policy, including Copernicus and Galileo; and raw materials. Analyses of the implementation and interaction of EU legislation and how they collectively support re-industrialisation and competitiveness are also done as part of the Commission's Regulatory Fitness and Performance Programme (REFIT). To accelerate EU growth, industry needs framework conditions that provide them with the basis upon which to invest, to innovate and to gain global market share in an increasingly competitive world. Standards are a cornerstone of these conditions and will be an integral part of Horizon 2020. The JRC contributes substantially to supporting the standardisation system. This ranges from pre-normative research, harmonized methods and the development of reference measurements and methodologies. A measurements and standards helpdesk exists to support the Commission's services and there is Commission participation in the various working groups of European and international standardization bodies. Additionally, certified reference materials demanded by EU legislation are provided, as well as metrological support.

JRC also provide harmonised methodologies for the characterisation of (nano)materials and products (e.g. textiles, toys) and contribute to EU standardisation in bio- and nanotechnologies. JRC has developed the first industrial-based measurement standards which are of relevance to EU legislation defining a 'nanomaterial' and for provisions in REACH legislation (the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals). The JRC brings together users and suppliers of security systems and solutions to define in-practice standards and test protocols, most recently for aviation security screening products. Furthermore support the Construction 2020 action plan, which aims at promoting climate, environmental and energy-related objectives. The JRC experts also lead the implementation and further development of the Eurocodes (European standards for structural design in construction).Reference tests on full-scale specimens of buildings and civil infrastructure are done at the JRC's European Laboratory for Structural Assessment (ELSA).

2.2.3 Environment

The JRC contributes to the integration of environmental information systems. It plays a key role in the implementation of the Infrastructure for Spatial information in the EC (INSPIRE) and the Shared Environmental Information System (SEIS). It is responsible for ensuring the viability and evolution of the INSPIRE technical infrastructure, guaranteeing cooperation with the international research community. It also plays an active role in standardisation bodies, thus helping to address demands from the Member States on interoperability between INSPIRE infrastructures for environmental policy and other e-infrastructures.

2.2.4 Food, Feed and Product Safety and Quality

JRC is developing in-vitro methods for hazard assessment of nanomaterials, represent the Commission in related European and international standards organisations, and support international consensus on risk assessment methodologies for nanomaterials (OECD, ISO, CEN). The JRC supports the development and validation of a new generation of alternative methods to reduce the necessity for testing on animals, and to provide more cost-effective tools for assessing health effects specific to humans. This includes in-vitro cell-based tests and computational models for predicting toxicity. Much of this effort falls within the activities of the EU Reference Laboratory for Alternatives to Animal Testing, hosted by the Center. JRC also provides support to standardisation and harmonization of alternative methods towards international regulatory acceptance (e.g. OECD, International cooperation on alternative test methods).

2.2.5 Health

Through the production of reference materials and support to the establishment of guidelines for clinical measurements, JRC contributes to the standardisation and traceability of results for in-vitro diagnostics, and thus to their reliability and comparability. Over 40 different reference materials are available, including those for tumor markers, markers for infectious diseases and cardiac damage. JRC Institutions' work, through worldwide collaborations, also facilitates international standardization.

2.2.6 International Cooperation and Enlargement

The JRC contributes to standardisation via pre-normative research, working towards harmonized methods, and developing reference Measurements and methodologies. Together with the US National Institutes of Science and Technology (NIST), JRC is collaborating on standards and measurements in several areas, ranging from energy and transport, to nanotechnology and healthcare. Such collaboration is relevant in the framework of the Transatlantic Trade and Investment Partnership (TTIP) negotiations, as it will help to build a regulatory level playing field. The collaboration with the US department of Energy (DoE) on smart grids and e-vehicles interoperability aims at harmonising test procedures; development and verification of connectivity technologies, communication protocols and standards; as well as identification of gaps where new standards or enabling technologies are needed. This cooperation contributes to the work of the Transatlantic Economic Council and provides tangible deliverables: the first Interoperability Centre was inaugurated in July 2013 at the DoE Argonne National Laboratory in Chicago and the European Interoperability Centre was inaugurated at the JRC premises in Ispra, Italy, in 2015.

2.2.7 Mobility and Transport

The JRC supports the EU Action Plan for Deployment of Intelligent Transport Systems (ITS) with harmonization and standardisation work focusing on security and privacy of applications (i.e. professional drivers e-documents, EU-US Harmonisation Task Group on harmonized policies for cooperative ITS Security Implementation). JRC carries out experimental research on a number of challenges facing the transition to a low carbon transport. This includes analysis of the performance and safety of electric vehicles and their batteries, and pre-normative research on global standards for electric vehicle and smart grid interoperability, as well as on standards for electric charging and hydrogen refueling. The work on hydrogen and fuel cell technologies focuses on the harmonisation and validation of test protocols, assessment procedures for performance and safety, and measurement techniques and methodologies as input to regulations and standardisation. Research on alternative fuels (non-petroleum) is TRADE With the Argonne National Laboratories of the US Department of Energy; the JRC is looking into standardisation and harmonisation of electric vehicles, e-vehicle components as well as the interaction of the electric vehicles with the grid. An agreement has been made to establish twin electric vehicle smart grid interoperability centers both in the US and in the EU, at the JRC's premises.

2.2.8 Committees and relative Groups for Standardisation

The JRC Standardisation Task Force and the JRC Standardisation Steering Committee are two of the main internal committees who are cooperating closely with all the JRC Institutions and the other EC DGs and their bodies as well for these issues. They provide advisory work and comprehensive proposals to the DG JRC similar to the new established JRC Knowledge and Competence Centers. In additional close collaboration with the EC's Joint Initiation for Standardisation (JIS) is expected to contribute positively in this direction by accelerating and optimizing the results.

3 EU Future Initiatives for Standardisation and Innovation

3.1 Modernising of European standards system

Standards are crucial for innovation and progress in the Single Market: they increase safety, interoperability and competition and help remove trade barriers. They are essential for European competitiveness. Over the past decades, the European Standardisation System has greatly contributed to this success. A recent study from the UK shows that the use of standards contributed over 28 % to UK productivity growth, while the benefit to companies in general from the use of standards is valued at up to 5% of their annual turnover. The success has been possible due to a unique public private partnership between the European regulator and European standardisation community. But the standardisation process faces challenges from the changing nature of the economy and diversification of business models, the ever-increasing role of information and communication technology, and the growing importance of services in today's global value chains, where goods and services are increasingly provided together in a package. The European Standardisation System needs to be up to these challenges, producing timely and market-driven standards in an inclusive way and consolidating Europe's leadership in international standardisation. European standards need to support EU policies and for digital innovations, they need to offer increased security and interoperability.

This is why the Digital Single Market Strategy launched an integrated standardisation priority plan with a focus on ICT technologies and a review of the European interoperability framework. More generally, this means modernising the existing partnership. The European Commission will therefore propose a 'Joint initiative on Standardisation' between the European Commission, the industry concerned, European standardisation organisations and the standardisation community in general. The Joint initiative will aim to speed up and better prioritise standard setting across the board. Following discussion with stakeholders, the Joint initiative could be agreed in early 2016. In addition, there remains significant untapped potential from the development and use of voluntary European service standards to address servicification and deliver an integrated European services market. Such standards could reduce costs and market fragmentation yet currently account for only 2 % of all EU standards.

Last but not least the expected revised issue of cooperation agreement among CEN, CENELEC and JRC will contribute on the above goals.

Drawing on the successful experience acquired for products, the European Commission will issue dedicated guidance, exploring the issues, including ensuring that such standards are demand-led and adopted where they are most needed. : To modernise the European standardisation system, the Commission will propose and agree a 'Joint initiative on Standardisation' with the European standardisation community. It will also issue dedicated guidance on service standardisation. This will give businesses and consumers confidence in cross-border services and enhance cross-border trade (COM(2015) 550 final, 28-20-2015).

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Reputation Gap and Exports in Developing Countries: Does International Quality Certification Matter?

Cesare A.F. Riillo[1], Ivana Mijatovic [2]

[1] Agence pour la normalisation et l'économie de la connaissance (ANEC)
National Institute for Statistics and economic studies of the Grand Duchy of Luxembourg (STATEC); Luxembourg
E-mail: cesare.riillo@statec.etat.lu

[2]University of Belgrade, Faculty of Organizational Sciences,Department of Quality Management and Standardization, Belgrade, Serbia
E-mail: ivanamt@fon.bg.ac.rs

Abstract *Export can be hindered by reputation gap of firms operating in developing countries. This paper explores influence of international certification on export in the case of the Eastern European countries. We use data from Enterprise Surveys, conducted by the World Bank in 2013 that includes 5632 small and large manufacturing and service firms from 26 Eastern European countries. We implement a bivariate probit model to account for simultaneity and endogeneity issues. Results show that certification increases the chances of exporting goods and services. Our findings also provide evidence that larger and older companies as well as companies with good ICT capabilities are more likely to be certified. Our results emphasize that international certification is connected with "building of reputation" and it may benefit companies from developing countries.*

1 Introduction

According to The Guardian global inequality is still growing and half the world's wealth now is in the hands of just 1% of the population (Treanor, 2015). Inequality is dysfunctional, it slows economic growth, results in health and social problems and generates political instability and there is a grave need to place equity at the center of the development agendas (Ortiz, 2011). However, inequality has been universal throughout humans' existence, varying over time and place in its form, intensity, and consequences (Dowd, 2009). Even those roots and causes of economic inequality are numerous and might be specific in different countries it is ongoing debate about the roles of international financial and other institutions, big business, trade agreements, education, politics etc.

Global changes that are affecting areas as diverse as international trade, employment legislation and work conditions, public services, poverty, welfare, inequality and mental health (Walker, 2015). However, the new technological revolution has led to the marginalization most of the developing countries exporting predominantly because of the low quality and low value-added manufacturing (Acharyya, 2005). It is almost a myth that many companies from developing countries have problems to comply with globally accepted standards, however even domestic markets are under the influence of global market and many local producers are losing the game even on their own market.

It is clear that global market is far from ideal of the International Accreditation Forum (IAF) "Certified Once Accepted Everywhere". Report from WTO meeting (WTO, 2013) about how to make easier products certification for developing countries, underline that developing countries are particularly handicapped and that they face many difficulties "in meeting the standards needed for their goods and services to be certified, and for their laboratories and inspection services to be accredited as having sufficient technical competence and thus providing confidence for trade."

The main objective of the research presented in this paper is to explore influence of international certification on export in the case of the Eastern European countries. The paper is structured as follows. The next section introduces literature review. The third section deals with the methodology while the fourth section reports results. Finally, the fifth section derives discussion based on the results and conclusion remarks.

2 Literature Review

There are many different cause and effects relationships between standards and markets - standards can constitute markets, shape behaviour on markets, define characteristics of the markets or set the framework of the markets (see more, Hesser, 2007, pp.458). Market for products and services is in many ways connected to "crystallization of regulation, technical standards, certification, accreditation into granting – or not granting – a product the right to enter to specific market (Frankel and Galland, 2015). The same authors were arguing about many relations between market and regulation and underline that regulation and standards can make new markets e.g. market for certification services. Proliferation of certification standards practically has developed market for consultancy, certification and accreditation services in many countries as well as globally. On the other side, consultancy, certification and accreditation services providers have become strong influencers in developing new certification standards as well as in developing new certification programmes. A variety of stakeholders have been motivated in recent years to set standards and develop private certification schemes with different motivation. The certification industry is become strong and influential in many areas – from organic agriculture, bio fuels to management system standards and IT services. Certification industry is booming, actors in certification often have their own economic and others interests.

What is certification? Certification is the provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements (http://www.iso.org/iso/home/standards/certification.htm). In many cases specific requirement are defined by standards. Certification is a form of communication along the supply chain that permits the buyer to been assured that the supplier complies with certain requirements (Dankers, 2003).

No matter who is proponent of certification or whether is certification is related to mandatory regulation (e.g. Halal certification), voluntary initiatives (e.g. ISO 9001 certification) or by the private sector (e.g. Bluetooth certification), certification is often seen as important motivator for standards usage. Concerns related to developing countries' ability to effectively participate in the process of standards development as well as related to reliability of their certificates, highly influence market positions of producers and providers from developing countries. The ability and resources of companies and organizations from developing countries to effectively participate in standard development process and make substantial influence on standards are limited. The predominant standardization strategy of developing countries are "adopt standards first and improve capabilities" (Choung, Ji and Tahir, 2011).

Standards are a significant factor in who wins and who loses in the global marketplace and it's hard to win if you don't know the game (Bhatia, 2011). The state of art in many transitional countries is that transition from planned and central economy to market economy is still ongoing process and awareness about standardization and standards is quite different than in countries with tradition in market economy – national standardization bodies are governmental, government and state agencies are still seen as key initiators of initiatives related to specific industries. Roles of governments in standardization and certification are country specific. Governments provide the legal environment in which standardization and certification operate, legally protect the use of certain terms used for product labelling, government agencies may act as standard-setting or accreditation bodies and may also actively facilitate certification through: facilitation of local certification bodies; support to organizations advocating implementation of standards; subsidies or tax incentives to producers implementing standards; or through training of extension staff in the requirements of the standards (Dankers, 2003).

Proliferation of different standards, certification schemes and accreditation systems even within same sectors or specific aspects raise a number of concerns and ruin credibility of certification. However, in global and interconnected market, capital and knowledge it is hard to make boundaries to see what is domestic/laggard/from developing country/transitional or international/multinational/from developed country company. Existence and usage of many different standard cause losses for many companies either from developing or developed countries. The scandals related to consequences of usage of different standards on global market are not rare. One of the well-known is related to Coca Cola Company and Pepsi Co. Two angry rivals Coca-Cola and Pepsi Co (among others) were accused by Indian NGO, for unsafe products sold on Indian market in 2003, both companies along with many institutions based their defense on credibility of data provided by non-accredited laboratory and satisfying Indian standards, however general public have taken side of vulnerable side rather that of large multinational companies (Papyrina, 2010). However, implication for profitability, stock value, reputation and image of Coca-Cola and Pepsi Co, due this case were serious.

Three concepts might be helpful in understanding mutual need for high quality standards and reliable certification. First, cooperation among competitors to lower the risk of shared sanctions due the errors of individual company which can lead to establishing institution (if the right one does not exist), developing standard(s) and establishing certification programs. Increased risk of shared sanctions preceded the creation of the industry's self-regulatory programs, which can be able to prevent industry wide harm from the errors of individual firms - firms unite with rivals to ensure that each protects the other from a future problem and because they are "walling in" their own effect on their neighbors, firms cannot achieve such results independently (Barnett and King, 2008). According to the same authors, after the Bhopal gas tragedy many chemical companies wanted to collaborate with rivals to establish industry agreements and standards to prevent reoccurrences of the similar tragedy.

Second, the concept of "regulatory capture" in which some companies may lobby and persuade the standards development organization (SDO) to define standards in the interest of lobbyists rather than in the mutual interest of all parties included (Blind, 2004, pp. 22). Standards as a base for certification can be developed without involvement of a sufficient variety of stakeholders and their usage can support or prevent specific producers or providers to enter to a specific market.

Third, concept of manipulation with minimal quality and/or safety requirements in standards or "raising rivals' costs" (Blind, 2004, pp. 22) in which some companies or consortia may lobby for unnecessary high quality or safety requirements which can cause that many rival companies cannot satisfy new requirements. To prescriptive standards can reduce choice of products or services at the market, on the other side standards with too general requirements can make substantial difference in their interpretation and certification in accordance with them might be unreliable. Lobbing is not ending at SDOs and industry self-regulations are base for technical regulations. Fear that influential companies can manipulate with unnecessary high requirements in standards and some others manipulate with certificates ruins trust in certification in general.

The possibility of achieving significant export growth by the developing countries has further been constrained by the quality regulations and environmental standards that are often in place on the imports by the advanced industrialized countries (Dankers, 2003). Export from developing countries enters to the international market through multi-certification and foreign imports to developing countries are far less conditioned by certification (Xie et al, 2011). A loss of competitiveness due to the costs required to comply with these standards has arisen concern among exporting firms, particularly those in developing countries (Keiichiro et al., 2015). The firm-level study of Keiichiro et al. (2015), reports about negative effects of food safety standards to impose direct/indirect and one-time/recurring costs on exporting firms in developing countries.

Some problems of international certification can be seen in "local flexibility versus global credibility of certification programmes" - local specificity may be further taken into account through a system of generic standards that are complemented by local or specific standards, or by a system of minimum and progress standards (Dankers, 2003). Hudson and Orviska (2013) argued that single generic standards for all firms all sectors and all countries may not be optimal as they found differences in quality standard certification both within and between firms, sectors and countries. "Thus the argument can be made that standards such as ISO 9000 and ISO 14000 should be defined differently for firms in manufacturing as opposed to those in service sectors or for small as opposed to large firms. Larger firms, for example, will want more ambitious standards than smaller ones." (Hudson and Orviska, 2013)

The export performances are positively correlated with ISO 9001 and ISO 14001 certification (Masakure et al., 2009; Martincus et al, 2010; Ferro 2011; Hudson and Orviska, 2013; Goedhuys and Sleuwaegen 2013). The results of Blind, Mangelsdorf and Wilson (2013) showed that quality management certifications are positively correlated with bilateral trade; mutual recognition of certification has a positive and significant effect on trade and that mutual recognition is in particular beneficial for markets access in high-income countries. Exporters with experience have reputation which shapes their position on the market, while newcomers on the market need to 'get up to speed' more quickly - in this context, certification to ISO 9000 plays a key role in establishing their credibility (Masakure et al., 2009). ISO certification has effectively helped Argentine firms expand their exports and the effects of certification are larger on exports to developed countries and of differentiated products (Martincus et al, 2010). Using the 2002-2008 waves of the ENTERPRISE SURVEYS that covers on manufacturing firms only, Ferro (2011) investigates the relationship between signalling tools such as certification and reports that certified firms have more chances to be exporters. Against a large dataset of manufacturing firms operating in 59 countries Goedhuys and Sleuwaegen (2013) found that: "the international standard certification raises productivity and sales performance of firms through efficiency gains and quality signaling, with the effects being larger in countries where market supporting institutions are weak. The largest gain in performance comes from direct productivity improvements helping firms to climb the technological ladder and closing the productivity gap with firms based in developed countries".

3 Methodology

3.1 Research Question

The research presented in this paper was driven by research question whether international quality certification increases the likelihood of exporting in observed Eastern European Countries.

3.2 Data

The quantitative analysis is based on Enterprise Surveys, conducted by the World Bank in 2013. The data are cross sectional and include 5632 small and large manufacturing and service firms of 26 Eastern European countries that are covered by the last available wave of the Enterprise Survey. The Enterprise Surveys Data of the World Bank is the main official data source for firm level firms in developing countries. The survey collects information about firms' characteristics and the markets, including international-recognized quality certification and exports activities. The surveys are administered to a representative sample of firms in the non-agricultural formal private economy. The universe of the survey, also known as the population, is consistently defined in all countries and includes the entire manufacturing sector, the services sector, and the transportation and construction sectors. Public utilities, government services, health care, and financial services sectors are not included in the universe. Uniform universe and uniform methodology of implementation allow comparability across countries.

4 Results

Descriptive statistics are presented in . Certification and exports activities are correlates.

Table 1. Among firms with certification, 34% are exporting companies, compared with only 11,4 % of the exporting firms without a certification. Certification and exports activities are correlates.

Table 1. Descriptive statistics by international quality certification

	(1) No certification mean	sd	(2) Certification mean	sd
Direct Exports	0.114		0.340	
Ln Employees	2.862	1.135	3.724	1.404
Ln Age	2.496	0.631	2.687	0.652
Leather	0.012		0.004	
Garments	0.053		0.042	
Food	0.072		0.111	
Metals and machinery	0.053		0.093	
Electronics	0.008		0.017	
Chemicals and pharmaceuticals	0.011		0.044	
Wood and furniture	0.034		0.027	
Non-metallic and plastic materials	0.053		0.090	
Other manufacturing	0.038		0.048	
Retail and wholesale trade	0.408		0.254	
Hotels and restaurants	0.065		0.036	

Other Services	0.090		0.094	
Other: construction, transportation, etc.	0.076		0.101	
	1.000		1.000	
Albania	0.052		0.040	
Armenia	0.057		0.053	
Azerbaijan	0.076		0.026	
Belarus	0.028		0.016	
Bosnia and Herzegovina	0.043		0.061	
Bulgaria	0.035		0.036	
Croatia	0.026		0.022	
Estonia	0.010		0.009	
Fyr Macedonia	0.044		0.055	
Georgia	0.019		0.013	
Hungary	0.015		0.061	
Kazakhstan	0.035		0.030	
Kosovo	0.031		0.040	
Kirgyz Republic	0.048		0.040	
Latvia	0.025		0.012	
Lithuania	0.020		0.014	
Moldova	0.052		0.021	
Montenegro	0.017		0.013	
Poland	0.027		0.044	
Romania	0.057		0.081	
Serbia	0.035		0.051	
Slovak Republic	0.013		0.033	
Slovenia	0.010		0.008	
Turkey	0.071		0.151	
Ukraine	0.115		0.060	
	1.000		1.000	
Website communication	0.511		0.789	0.408
Foreign Ownership	0.048		0.120	0.325
Financial Auditors	0.376		0.546	0.498
Foreign Technology	0.111		0.287	0.453
ln tax controls	0.569	0.679	0.614	0.710
Observations	3298		1240	

4.1 Econometric Analyses

The econometric analysis allows investigating the relationship between certification and exports considering all features simultaneously. In particular, we are interested to estimate whether international quality certification increases the likelihood of exporting. We implement a bivariate model to account for endogeneity of quality certification and export.[1] First, export and quality certification are investigated as separated events in the frame of the probit model (e.g. Greene, 2003). This is modellization is appropriate because both export and certification are dichotomous.

[1] Other studies on these data focus on productivity and do not explicitly model the possible endogeneity of certification and export (Ferro, 2011). Additionally our study covers service and manufacturing firms.

Second, suspecting that the certification and exports are related activities and unobserved factors (e.g. management culture) could affect the results of the first step, certification and export are jointly investigated in the frame of the recursive bivariate probit model (Greene, 2003). In this model, the errors of the equation explaining the certification are correlated with the errors of the equation explaining the export. The certification is included in the right–hand side of export equation.

In formula:

$$y_1^* = \boldsymbol{x}_1^{'}\boldsymbol{\beta}_1 + \gamma y_2 + \varepsilon_1, \qquad y_1 = 1 \ \text{ if } y_1^* > 0, \quad 0 \ otherwise$$

$$y_2^* = \boldsymbol{x}_2^{'}\boldsymbol{\beta}_2 + \varepsilon_1, \qquad y_2 = 1 \ \text{ if } y_2^* > 0, \quad 0 \ otherwise$$

$$E[\varepsilon_1|\boldsymbol{x}_1, \boldsymbol{x}_2] = E[\varepsilon_2|\boldsymbol{x}_1, \boldsymbol{x}_2] = 0$$

$$\text{Var}[\varepsilon_1|\boldsymbol{x}_1, \boldsymbol{x}_2] = \text{Var}[\varepsilon_2|\boldsymbol{x}_1, \boldsymbol{x}_2] = 1$$

$$\text{Cov}[\varepsilon_1, \varepsilon_2|\boldsymbol{x}_1, \boldsymbol{x}_2] = \rho$$

Where $y_1 = 1$ if the firm directly export, $y_2 = 1$ if the firm serves national market only, $\boldsymbol{x}_2^{'}$are control variables of equation explaining certification and $\boldsymbol{x}_1^{'}$ are control variables of equation explaining export.

Finally we extend the bivariate probit including variables that capture reputation of the firm that can influence both certification and export: foreign ownership and external financial auditors. Being part of a foreign ownership can reduce reputation gap in the perception of customers (i.e. Skoda is part of Volkswagen group) and provide knowledge that can facilitate export and possible decrease the costs of certification. Similar argument applies to external financial auditors. Firms experiencing external (financial) auditing are more experienced with reporting and procedures that are part of management certification process. At the same time, external financial auditing as it is external can potential increase confidence of customers in the company.

The marginal effect and some regression statistics are reported in Table 3. Only marginal effects are reported because more easy to interpret. Tables with the regression coefficients are in appendix. First we discuss the propensity to be certified. Results are reported in Table 2. Equation 1 is the probit estimation of international quality certification. Equation 1includes two instrumental variables: use of licensed for foreign technologies and tax controls i.e. number of day measures the number of times per year the firm. "The rationale for including these instruments is that firms that use licenses are often forced by the licensors to implement international standards certification (ISC), while firms that are subject to greater controls from tax authorities have self-interest in being transparent and in following codified procedures about the way they organize their activities and transactions. An ISC serves this purpose well and, hence, we expect firms subject to control from external private partners or public authorities to adopt ISC" (Goedhuys & Sleuwaegen, 2013. p 92).

Aside country and sector fix effects, we note that larger and older firms are more likely to get certified. Firms with good ICT capabilities, approximated as communication with customers by website are more likely to be certified. Web communication increases certification probability from 12.3 percentage points in equation (1) to 10.5% in equation (3). Equation 2 shows that use of foreign technology and foreign ownership are positively correlated with certification (15% and 2.6% respectively). The impact is similar in equation (3). Foreign ownership (7.65%) and financial revision (4.19%) of external auditors are positively related to certification.

Table 2.Propensity of International quality *certification* *APE*

	(1) Probit	(2) biprobit	(3) biprobit with reputation variable
Ln Employees	0.0722***	0.0638***	0.0575***
	(12.05)	(10.45)	(8.44)
Ln Age	0.0218*	0.0260**	0.0284**
	(1.79)	(2.15)	(2.25)
Website communication	0.123***	0.109***	0.105***
	(8.51)	(8.03)	(7.71)
1.Foreign Technology		0.150***	0.139***
		(7.62)	(7.02)
ln tax controls		0.0257**	0.0239*
		(2.02)	(1.90)
1.Foreign Ownership			0.0765**
			(2.44)
1.External financial Auditors			0.0419***
			(3.13)

t statistics in parentheses
Notes: Estimation statistics are reported inTable 2; Country and sector dummies included in the estimations and are reported in Table 4 annex.
* p<.10, ** p<.05, *** p<.01

Table 3 show the impact of Certification on export activity. It appears that certification positively impact the exports in any model. The magnitude of the impact is 7.15% in equation (4), 15.9% in equation (5) and 10.6% in equation (6). It is interesting to note that the impact is lowest in equation (4) when the model is considering certification as exogenous. When certification is function of other variables and unobservable factors can influence both certification and export the impact of certification is much stronger. We note that the rho, the correlation between certification and export is negative and statistically significant at 10%. We interpret this negative correlation as the result of unobservable reputation of the firm. Aside other factors, higher reputation of the firm, higher is the probability of export but lower is the necessity of certification. This interpretation is consistent with result of equation (6). Indeed controlling for variables that capture reputation of the firm in foreign customers (foreign ownership and external financial auditors), the impact of certification decreases in magnitude and significance. Interestingly, the Rho is not statistically significant when controlling for reputation variables.

Table 3 .Propensity of *direct exports* *APE*

	(4) Probit	(5) biprobit	(6) biprobit with reputation variable
International quality	0.0715***	0.159***	0.106**

certification			
	(5.14)	(3.88)	(2.07)
Ln Employees	0.0409***	0.0321***	0.0320***
	(7.14)	(3.91)	(3.59)
Ln Age	-0.000319	-0.00247	0.00329
	(-0.05)	(-0.40)	(0.53)
Website communication	0.0729***	0.0595***	0.0642***
	(4.09)	(3.71)	(4.18)
Foreign Ownership			0.123***
			(3.85)
External Financial Auditors			0.00524
			(0.46)
LL	-1492.6	-3643.0	-3610.4
RHO		-0.297	-0.137
Pseudo R2	0.292		
Wald test of rho=0:		chi2(1) = 3.05928 Prob > chi2 = 0.0803	chi2(1) = .484615 Prob > chi2 = 0.4863
Obs.	4538	4538	4538

t statistics in parentheses
Notes: Country and sector dummies included in the estimation and are reported in Table 5 in annex
* p<.10, ** p<.05, *** p<.01

5 Discussion and Conclusions

The main intention in this paper was to explore whether international quality certification increases the likelihood of exporting in observed Eastern European Countries. To answer our research questions, we used data from ENTERPRISE SURVEYS, conducted by the World Bank in 2013. Our analysis included 5632 small and large manufacturing and service firms of 26 Eastern European countries. Our findings show that larger and older companies as well as companies with good ICT capabilities, approximated as usage of ICT in communication with customers are more likely to be certified. Companies that are more connected with foreign companies (foreign technology and foreign ownership) are more likely to be certified. In a broad sense our findings are compliant with those of Hudson and Orviska (2013).

However, if the companies which operate in Eastern Europe have foreign ownership and they export than impact of certification decreases in magnitude and significance. Our results suggest that international certification is more important to the companies from developing countries and it is connected with “building of reputation”. In this context our results are compliant with those of Masakure et al., (2009) – that international certification is more important for newcomers on the market who need to ‘get up to speed’ more quickly. Based on our results, we might conclude that interest of exporter companies from developing countries is to sustain credibility of international certification. It is not an easy task in situation where proliferation of different standards and certification schemes are evident in many sectors and trust in certificates are questionable. Certification is always a means, and should not become an end in itself (Dankers, 2003).

Hudson and Orviska (2013) claim “that single generic standards for all firms all sectors and all countries may not be optimal” should be considered very carefully in the context of developing countries. Even with the single generic standards, their interpretations as well as commercialization of certification depend on business culture and tradition which shape general trust in certificates issued in one country. Diversification of standards in order to have different standards for developing and developed is step back. However, in a broad sense our findings suggest that international standardization and certification might start to become dominantly focused on developing countries. With lowering the level of interest and influence by developed, but focused on developing international standardization and certification will start to be less influential on global market even for developing countries. Improving quality of standards, building trust to international certification globally and new mechanisms of accreditation are needed.

Improving quality of international standards is sensitive topic. Many international standards are not ambitious enough for well-organized successful companies – majority of standards are related to good practice not to the best practice.Concerns that more influential companies can use “regulatory capture” or “raise rivals’ costs” to protect their market from others, make influence of large international companies on international standards development quite controversial. However, many international standards developed without participation the leading companies in the sector might be unaccepted on the developed markets.Strengthening abilities and capacities of companies from developing countries to effectively participate in the processes of standards development as well as rising the chances to their influence on solutions which are in standards might be wise decision for developing countries. Not only in arena of international standardization.

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ANNEX

Table 4 Propensity of International quality certification APE

	(1) Probit	(2) Biprobit	(3) biprobit with reputation variable
Ln Employees	0.0712***	0.0630***	0.0567***
	(12.03)	(10.34)	(8.44)
Ln Age	0.0222*	0.0262**	0.0286**
	(1.83)	(2.18)	(2.28)
Leather	-0.0356**	-0.0209	-0.0117
	(-2.21)	(-1.27)	(-0.70)
Garments	-0.00864	0.00719	0.00726
	(-0.24)	(0.20)	(0.20)
Food	0.110***	0.110***	0.114***
	(2.76)	(2.88)	(2.93)
Metals and machinery	0.0982**	0.0942**	0.0956**
	(2.45)	(2.44)	(2.43)
Electronics	0.113**	0.0958*	0.0973
	(2.02)	(1.65)	(1.64)
Chemicals and pharmaceuticals	0.182***	0.173***	0.166***
	(5.08)	(4.90)	(4.49)
Wood and furniture	-0.0417	-0.0370	-0.0333
	(-0.88)	(-0.82)	(-0.73)
Non-metallic and plastic materials	0.107***	0.106***	0.108***
	(3.19)	(3.13)	(3.14)
Other manufacturing	0.0358	0.0367	0.0381
	(0.96)	(1.02)	(1.02)
Retail and wholesale trade	-0.0345	-0.0302	-0.0287
	(-1.22)	(-1.16)	(-1.07)
Hotels and restaurants	-0.0395	-0.0272	-0.0239
	(-0.56)	(-0.39)	(-0.34)
Other Services	0.0402	0.0315	0.0325
	(1.19)	(0.89)	(0.90)
Other: construction, transportation, etc.	0.0461	0.0542	0.0597
	(1.16)	(1.36)	(1.49)
Albania	0.268***	0.221***	0.235***
	(22.86)	(13.59)	(15.51)
Armenia	0.185***	0.165***	0.177***
	(23.51)	(20.14)	(17.75)
Azerbaijan	0.105***	0.0547***	0.0627***
	(11.73)	(6.25)	(7.73)
Belarus	0.110***	0.114***	0.103***
	(5.56)	(5.41)	(4.61)
Bosnia and Herzegovina	0.287***	0.265***	0.255***
	(25.46)	(21.06)	(22.55)
Bulgaria	0.227***	0.210***	0.211***
	(23.85)	(17.03)	(16.95)
Croatia	0.183***	0.166***	0.167***
	(17.29)	(14.08)	(13.90)
Estonia	0.177***	0.147***	0.146***

	(16.13)	(13.36)	(13.08)
Fyr Macedonia	0.328***	0.297***	0.306***
	(31.69)	(23.77)	(24.02)
Georgia	0.158***	0.134***	0.137***
	(15.66)	(13.64)	(13.43)
Hungary	0.477***	0.470***	0.473***
	(52.83)	(47.48)	(47.67)
Kazakhstan	0.200***	0.192***	0.203***
	(19.96)	(19.79)	(18.88)
Kosovo	0.272***	0.222***	0.242***
	(32.40)	(19.22)	(19.78)
Kirgyz Republic	0.178***	0.169***	0.168***
	(29.47)	(28.25)	(25.29)
Latvia	0.154***	0.150***	0.144***
	(14.33)	(14.01)	(13.78)
Lithuania	0.112***	0.0929***	0.0988***
	(9.28)	(7.19)	(7.30)
Moldova	0.105***	0.0810***	0.0889***
	(11.27)	(7.29)	(7.98)
Montenegro	0.236***	0.203***	0.205***
	(25.91)	(16.32)	(15.96)
Poland	0.250***	0.239***	0.253***
	(17.86)	(17.33)	(16.14)
Romania	0.290***	0.270***	0.271***
	(28.92)	(23.03)	(22.65)
Serbia	0.280***	0.263***	0.265***
	(21.10)	(18.70)	(18.80)
Slovak Republic	0.380***	0.342***	0.343***
	(25.53)	(20.94)	(21.52)
Slovenia	0.141***	0.125***	0.122***
	(11.48)	(8.66)	(7.81)
Turkey	0.280***	0.256***	0.262***
	(25.71)	(22.23)	(22.83)
Ukraine	0.0773***	0.0638***	0.0765***
	(7.17)	(6.15)	(6.98)
E-mail communication only	0.0468	0.0436	0.0436
	(1.33)	(1.40)	(1.36)
Web-site communication	0.158***	0.142***	0.138***
	(4.38)	(4.34)	(4.07)
1.Foreign Technology		0.148***	0.137***
		(7.64)	(7.11)
ln tax controls		0.0260**	0.0242*
		(2.05)	(1.93)
1.Foreign Ownership			0.0764**
			(2.44)
1.Financial Auditors			0.0416***
			(3.16)
LL	-1492.6	-3643.0	-3610.4
RHO		-0.297	-0.137
Pseudo R2	0.292		
Wald test of rho=0:		chi2(1) = 3.059 Prob > chi2 =	chi2(1) = .4846 Prob > chi2 =

		0.0803	0.4863
Obs.	4538	4538	4538

t statistics in parentheses
Notes: Uzbekistan and textile are the reference categories for country and sectors respectively
* p<.10, ** p<.05, *** p<.01

Table 5 Propensity of direct exports APE

	(1) Probit	(2) biprobit	(3) biprobit with reputation variable
International quality certification	0.0715***	0.159***	0.106**
	(5.14)	(3.88)	(2.07)
Ln Employees	0.0409***	0.0321***	0.0320***
	(7.14)	(3.91)	(3.59)
Ln Age	-0.000319	-0.00247	0.00329
	(-0.05)	(-0.40)	(0.53)
Leather	-0.311***	-0.297***	-0.310***
	(-31.38)	(-30.46)	(-33.02)
Garments	-0.0332	-0.0314	-0.0338*
	(-1.62)	(-1.41)	(-1.65)
Food	-0.142***	-0.149***	-0.143***
	(-5.92)	(-5.82)	(-5.99)
Metals and machinery	-0.0436	-0.0529	-0.0496
	(-1.40)	(-1.53)	(-1.42)
Electronics	-0.0374	-0.0488	-0.0480
	(-0.90)	(-1.17)	(-1.20)
Chemicals and pharmaceuticals	0.0298	0.00900	0.00954
	(0.54)	(0.15)	(0.16)
Wood and furniture	-0.0601**	-0.0542**	-0.0563**
	(-2.37)	(-2.34)	(-2.37)
Non-metallic and plastic materials	-0.0433	-0.0539	-0.0483
	(-1.37)	(-1.60)	(-1.39)
Other manufacturing	-0.0841***	-0.0853***	-0.0880***
	(-3.26)	(-3.12)	(-3.25)
Retail and wholesale trade	-0.236***	-0.226***	-0.231***
	(-8.57)	(-8.60)	(-8.75)
Hotels and restaurants	-0.307***	-0.293***	-0.301***
	(-6.89)	(-6.74)	(-6.70)
Other Services	-0.111***	-0.112***	-0.113***
	(-4.31)	(-4.28)	(-4.44)
Other: construction, transportation, etc	-0.288***	-0.285***	-0.278***
	(-5.31)	(-5.36)	(-5.23)
Albania	0.115***	0.0882***	0.109***
	(9.32)	(3.97)	(4.00)
Armenia	0.0961***	0.0777***	0.0935***
	(13.70)	(5.82)	(5.44)
Azerbaijan	-0.0764***	-0.0812***	-0.0592***
	(-10.42)	(-11.08)	(-5.09)
Belarus	0.118***	0.104***	0.105***

	(5.54)	(4.05)	(4.02)
Bosnia and Herzegovina	0.213***	0.180***	0.200***
	(26.14)	(8.69)	(8.29)
Bulgaria	0.201***	0.175***	0.193***
	(27.51)	(9.99)	(9.30)
Croatia	0.222***	0.200***	0.218***
	(23.20)	(11.03)	(10.40)
Estonia	0.267***	0.243***	0.259***
	(24.82)	(13.04)	(12.54)
Fyr Macedonia	0.236***	0.200***	0.223***
	(21.42)	(8.27)	(7.74)
Georgia	0.0682***	0.0513***	0.0685***
	(8.26)	(3.94)	(4.22)
Hungary	0.118***	0.0670**	0.105***
	(13.90)	(2.50)	(3.00)
Kazakhstan	0.0154**	-0.00193	0.0252
	(2.28)	(-0.18)	(1.48)
Kosovo	0.159***	0.129***	0.162***
	(16.19)	(6.14)	(5.96)
Kirgyz Republic	0.0681***	0.0529***	0.0544***
	(12.65)	(5.70)	(5.13)
Latvia	0.268***	0.245***	0.258***
	(36.02)	(14.61)	(14.12)
Lithuania	0.265***	0.244***	0.263***
	(32.32)	(15.03)	(14.33)
Moldova	0.0486***	0.0394***	0.0481***
	(5.24)	(3.26)	(3.47)
Montenegro	0.0398***	0.0156	0.0333*
	(4.68)	(0.99)	(1.76)
Poland	0.140***	0.113***	0.136***
	(15.15)	(6.08)	(5.64)
Romania	0.184***	0.152***	0.169***
	(21.25)	(7.37)	(6.98)
Serbia	0.235***	0.203***	0.227***
	(26.16)	(9.55)	(8.96)
Slovak Republic	0.179***	0.136***	0.166***
	(16.87)	(5.04)	(5.00)
Slovenia	0.360***	0.337***	0.346***
	(34.68)	(17.13)	(17.01)
Turkey	0.163***	0.133***	0.164***
	(19.57)	(7.20)	(6.94)
Ukraine	0.0477***	0.0406***	0.0576***
	(5.86)	(4.45)	(4.75)
Website communication	0.0729***	0.0595***	0.0642***
	(4.09)	(3.71)	(4.18)
Foreign Ownership			0.123***
			(3.85)
Financial Auditors			0.00524
			(0.46)
LL	-1492.6	-3643.0	-3610.4
RHO		-0.297	-0.137
Wald test of rho=0:		chi2(1) = 3.05928 Prob > chi2 = 0.0803	chi2(1) = .484615 Prob > chi2 = 0.4863
Obs.	4538	4538	4538

t statistics in parentheses
Notes: Uzbekistan and textile are the reference categories for country and sectors respectivelly
* p<.10, ** p<.05, *** p<.01

An Analysis of the Adoption of the ISO 9001 Standard Using the Activity System Model: Tensions in Practices and Expansive Learning

Hiam Serhan
AgroParisTech
hiam.serhan-murray@agroparistech.fr

Doudja Saidi-Kabeche
AgroParisTech
doudja.kabeche@agroparistech.fr

Abstract: *The ISO 9001 standard is a generic management tool composed of an artifact that incorporates expert scientific knowledge and operational techniques, a management philosophy which organizes its implementation and a reductionist view of the practical and interpersonal knowledge of the company. Paradoxically, it is oriented at the same time towards conformity driven by the codification and standardization of practices, and the exploration of the potential of the company in terms of the knowledge, skills and expertise on which it can lean in order to innovate. These orientations depend on the management style that is adopted when interpreting the standard and implementing it in a process of appropriation according to its requirements. During this process, the company undergoes tensions and disturbances arising from the interaction between expert and external knowledge and the reality that has already been standardized in behavior patterns that are difficult to change; and from the codification of knowledge in the form of Good Practices. In this paper we will be focusing on the tension arising from codification as it is perceived by actors and organizations from two different angles: for actors it is a paradoxical requirement, because in codifying their practices (often tacit) in an explicit form (distributable) they jeopardize their functions and feel dispossessed of their expertise. For organizations, it is a pertinent stage that will reveal a 'heritage of knowledge and skills'.*

In order to clarify the tension and disturbance that the codification requirement implies we shall mobilize, as a framework for analysis, Engeström's activity system and expansive learning model. We will use it to interpret the case of the multinational company Danone, which has succeeded in implementing the codification of good practices via an innovative experiment: the 'NetWorking Attitude'. Our objective is to show how Danone has succeeded in benefiting from the disruptions and tensions that arise from the paradox of the codification of organizational knowledge. Engeström's model renders visible the creativity of the management style in interpreting the utility of the codifying tool on the one hand, and on the other in expanding its scope of application, by aiming at exploration and innovation rather than conformity and the dispossession of skills. In this experiment, managerial creativity would appear to be an essential factor in the contextualization of the management tool and the exploitation of professional knowledge. Danone's project was not held as a requirement of the ISO 9001 standard but solely as knowledge codification and management project. It highlights the disturbances that this requirement provokes and which are considered as catalysts for creativity and dynamism.

Keywords: *ISO 9001 standard, codification of good practices, expansive learning, tensions, management pardoxes, innovation*

1 Introduction

After industrialization and the standardization of production, the human relations movement rendered visible the importance of social relations, motivation and employee satisfaction. Since, the history of organization Science has been shaped by management theories, tools and methodology stemming from several disciplines (psychology, sociology, economy and management) which attempt to simultaneously combine the objectives of an organization with those of its actors. In this participative management framework companies tend to become learning organizations that make use of an organizational memory that develops via individual learning (Argyris, 1976) and evolves by capitalizing on the knowledge attained by its actors (Nonaka, 1994).

This evolution is the symptom of modern and mature companies which seek to achieve two apparently paradoxical objectives: efficiency through stabilization and innovation through flexibility. Our aim of research is to study this paradox through the analysis of the stakes associated with the adoption of a management standard in an organization. We focus on the ISO 9001 quality management standard and try to provide an operational illustration of how a flexible and participative management team can confront its employees with their paradoxical attitudes and train them in a cycle of disturbances that foster creativity. Managing paradoxes result in a higher value for their activity, their skills and their place within an organization which in turn is supposed to learn from their learning, evolve through their evolution, and gain a lasting competitive advantage founded on their core skills and knowledge.

1.1 The paradox of organizations

In his famous book, *The empty raincoat*, Charles Handy says : "*Paradox I now see to be inevitable, endemic and perpetual. The more turbulent the times, the more complex the world, the more the paradoxes. (...) Paradoxes are like the weather, something to be lived with, not solved, the worst aspect mitigated, the best enjoyed and used as clues to the way forward. Paradoxes has to be accepted, coped with and made sense of, in life, in work, in community and among the nations*" (Handy, 1995). Organizations need also to do so. In order to understand changes in their environment, companies are driven to reconcile constraints that are usually perceived as conflicting: these companies must be local and global; they must keep exploiting professional expertise and yet develop new knowledge that will create new value; employees must be autonomous but capable of working in different teams. Managers must be "Masters of Paradox" (Hampden-Turner, 1994) in order to monitor and delegate; they need to decentralize, all the while staying integrated ; they have satisfy mass consumers while discovering niche markets (Handy, 1995). These managers must succeed in rendering visible the portfolio of immaterial resources made of professional knowledge, and gather the specialized skills dispersed among different practitioners in order to boost development and organizational learning (Grant, 1996). In the management of paradoxes, the role of managers consists in providing their employees with the resources that will help them to identify the company's critical knowledge assets (Saulais and Ermine, 2012) and to reconfigure it according to the new values inspired by the evolution of the environment.

To meet these challenges and remain competitive, a company engages change programs and reflects on its practices, knowledge, skills and relationships with the aim of developing flexible and reactive structures. New management tools and ideas are then introduced in the organization to support these change programs. Among the diverse management tools, we will focus in this paper on the ISO 9001 quality management standard. This standard, employed widely throughout the world (one million certifications in 2014), is often considered an instrument that steers actors towards becoming ambidextrous (O'Reilly &

Tushman, 2004) by simultaneously prescribing the exploitation of good organizational practices (standardization) and the exploration for new knowledge in order to create and innovate (innovation). We shall analyze it as a management tool structured around three interdependent components - an artifact that encompasses the requirements to be met, a management philosophy with which to put it in place, and a reductionist view of the knowledge and relationships of a company (Hatchuel and Weil, 1995). As a management tool, we will view the standard as a management innovation (Birkinshaw et al, 2008) conceived not only to ensure that practices conform to its rules, but above all to expand the organization's objectives, throwing light on the heritage of knowledge and skills on which it can lean to innovate.

The implementation of the ISO9001 standard requires written records of professional practices and the formulation of a reference document (Management Manual) which outlines the planning, resources, responsibilities and documented information to make it easier to verify, correct and improve practices. This approach towards the codification of operational practices is akin to a knowledge management process (Nonaka, 1994), since it consists in identifying, selecting, creating, capitalizing on and diffusing knowledge to all of the actors concerned in the form of Good Practices. However, this knowledge management generates tensions within organizations, which we shall analyze using the paradox of knowledge codification.

1.2 The paradox of knowledge codification

Companies undertaking the process for ISO 9001 certification must in the first instance meet the requirement of "documented information". They then find themselves confronted with the paradox of knowledge codification, which is related to the requirement of "written procedures". Indeed, the concept of codification - which is supposed to give access to the knowledge, expertise and skills which are useful for the company's development - is resisted by those employees involved in its implementation. Their resistance can be explained by the fact that they perceive the act of having to write down what they do and how they do it as something that strips them of their 'savoir-faire' (making their skills public) and jeopardizes their function.

In this paper, using the case of the ISO 9001 standard, we wish to clarify the question of cognitive and emotional tensions, which underpin the paradox of the codification of practices in every management system looking for both stability and flexibility; we shall also address the importance of management philosophy in dealing with these tensions within an organization. A management tool such as the ISO 9001 standard offers us a pertinent framework of study because the codification of practices plays a central role in the functioning of this tool in particular, and the style of management is determinant of the process of adopting the standard, that is to say it ensures that its use is coherent with the objectives of the organization.

Our aim of research is to provide an empirical illustration of the hypothesis that a participative management allows an organization to go beyond the objective originally formulated (such as “obtain the certificate”) and to move towards another whose value and significance are collectively constructed by a deliberate effort to learn. This is achieved through communication and exchanges between the different actors engaged in the management of paradoxes appearing during the implementation process. We will discuss these aspects drawing on an experience of the multinational company Danone. Danone has succeeded in implementing the codification of good practices via an innovative experiment: the 'NetWorking Attitude'.

2 Theoretical Framework

The quality management system known as the ISO 9001 standard is a 'Management system standard' which aims to improve the performance of organizations through a system that manages the quality of its procedures as a whole. We will mobilize features of this standard to highlight management paradoxes that occur during the implementation process of a management tool.

2.1 The ISO 9001 standard is an evolutionary management tool

Since its first publication in 1987, the standard has undergone four revisions. The 1994 version focused on how to conform the quality of a product or service according to the needs of the clients: it was the "quality assurance version". In 2000 version, the process approach was promoted and the PDCA cycle (Plan Do Check Act) was introduced with the 'continuous improvement requirement'. The 2008 version was centered around a systematic management style, based on the commitment of both the management and employees to continually meet the needs of the different interested parties of the company. The latest revision of the standard published in September 2015 introduces the necessity for every organization to adapt to the demands of the competitive environment. The company 'should define its risks and its opportunities' ("management of risks and opportunities" requirement) according to the needs and trends of its environment ("analysis and understanding of the internal and external context") and the potential of its heritage of knowledge and skills ("management of organizational knowledge").

The management of knowledge and organizational expertise is classed under the "Support" chapter of the standard among the resources that must be kept up-to-date and made available to all members of an organization. This requirement was introduced to protect the organization from any loss of knowledge (turnover), from the inability to collect and share strategic information; another aim was to encourage the organization to acquire knowledge from internal sources (knowledge acquired through experience, successful projects and improvements made to procedures, products and services) or external sources.

Through this evolution from "quality assurance" tool assuring the conformity of practices with the needs of clients to a management tool of organizational knowledge, the new version of the standard appears to be more geared towards creation and innovation than conformity. The "documented information" requirement remains however the first and final stage of every practice. It emphasizes the duty of the organization to codify, memorize and preserve practical knowledge as proof of conformity, in support of the evolution of practices.

We consider the ISO 9001 standard as a management tool comprising three interactive elements : it is simultaneously an artifact or technical substratum (the abstraction on which the tool is grounded is the encoded expert scientific and technical knowledge), a management philosophy or spirit in which it is planned to be used) and a simplified vision of organizational practices and relations (since it is designed to be flexible enough for use by many different types of organizations) (Hatchuel and Weil, 1995). It has been conceived to fulfill, paradoxically, the role of conforming practices with the rules that are introduced to make it possible to improve them (standardization) and the role of investigating the knowledge and skill set inherent to and surrounding the organization (exploration) in order to help it to innovate (Moisdon, 1997).

The Technical substratum or the artifact contains the rules that are to be implemented. Each of these rules made of encoded expert scientific and technical knowledge (Brunsson and Jacobsson, 2000). Such knowledge is derived from practices that are regularly tested within enterprises and in turn converted into so-called best practice(s) and from academic knowledge. Standards rules and requirements are developed by groups of experts, within technical committees (TCs). TCs are made up of representatives of industry, NGOs, governments and any other stakeholders, who are put forward by ISO's members (national standardization structures) (Brunsson and Jacobsson, 2000). Furthermore, performance control tools must be developed and put at the disposition of the auditing process so as to facilitate the verification of compliance.

The application of these standardization requirements is influenced by the managerial style or the management philosophy prevalent in organizations that deploy, interpret and implement the tool. This managerial style may be coercive or facilitate employee learning (Adler and Borys, 1996). According to Likert's classification, it can be exploitive, benevolent, consultative or participative (Likert, 1979). With a directive managerial style, the director delegates certain functions to a qualified internal supervisor or external consultant without involving employees. Top management is interested in certification rather than management. The risk is that after certification, all that is left are procedures encoded in the "quality manual", which employees mistakenly confuse with quality management. When the management style is participatory, top management genuinely wishes to improve its practices and knows perfectly well that the documented procedures (considered as paperwork in the first case) are necessary for obtaining a certain quality standard, reducing procedural costs and enhancing the performance of the system and its continual improvement. Employees write out the procedures that correspond to their own practices. So, they understand what they do and why they should do it differently.. In the case of the ISO 9001 standard, the skilled supervisor (quality manager, external consultant) is the actor that is situated on the frontline of the implementation and utilization of the standard (Benezech and al., 2001). Through our research hypothesis we assume that if the managerial style is participative, it can play a critical role in the management of paradoxes and tensions which arise between employees during the process of knowledge codification.

The ISO 9001 standard also implies a reductive vision of the organization. This standard was conceived far from users through the progressive distillation of its developers' expertise (Brunsson and Jacobson, 2000). Moreover, the creation of standards is coordinated by a standardization organism, which forms working groups (so called Technical Committees) consisting of experts in the field in question. These committees seek (as much as possible) to mirror stakeholders on the subject of standardization. In their work, they rely on the state of knowledge and on practical and/or academic know-how. Furthermore, the key principle involved in the creation of a standard is consensus amongst (groups of) experts. The dynamics of the interactions within these groups result in the development of a corpus of requirements (i.e. the technical substrate) that must be fulfilled (Brunsson and al., 2012). Accordingly, the standards produced are generic, that means that they are decontextualized from time and space by technical experts (Brunsson and Jacobsson, 2000) and contain statements that generate advices and requirements, which are themselves positioned to be universal (i.e. applicable to any organization regardless of its size or industry).

Polanyi underlines the value in distancing the user from expert knowledge by expressing this knowledge using language and symbols by which it becomes diffusible and open to critique. This distancing allows for expert knowledge to be augmented and improved given the interpretive variability of its content (Polanyi, 1958). This interpretive variability related to pragmatic ambiguity and ensures the adaptability of the tool (Giroux, 2006). Similarly, Ansari and al. argue that practices vary as they diffuse and their diffusion may be promoted by allowing sufficient space for particular types of adaptation. As the tool is engineered to be applicable to different local contexts it may diffuse easier in an organization. (Ansari and al, 2010 ; Ansari and al , 2014) .

2.2 The ambiguous implementation of the ISO 9001 standard and expansive learning

According to Grimand (2006), the appropriation of a management tool is an open perspective where the tool may be reinvented each time it is used. The author emphasizes that the appreciation of its value is inseparable from the creative capacity of its users and the manner in which they transform it. This is what makes the original invention meaningful and explains how it integrates part of whatever the subject invests and imprints, i.e. his/her intentions, style and activity. This is how the tool is transformed by the actor and the actor transformed by the tool (Hatchuel, 2005).

The same ideas are found in management innovations researches. A management innovation is the "The generation and implementation of a new management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals" (Birkinshaw & al., 2008). The creative mission of managers is emphasized. Managers must use the 'disruptive' factors that feature in their system as levers for expansive learning, which modifies the object and rules of the organization (Engeström, 2001, 2015). Therefore, in the case of standardization tools, it appears that the implementation of new knowledge in a practice is a double learning process: *Learning the code/standard* and *learning by the code/standard* (March, 1991) (Lambert & Loos-Baroin, 2004). The actors learn the codes and learn via the contradictions associated with the impact of this encoded knowledge on the activity in progress and on the competence of actors.

According to the ISO 9001: 2015 standard, competence is defined as 'the ability to apply knowledge and skills to achieve intended results' (www.iso.org). Putting knowledge and skills into practice could be achieved, argue Brown & Duguid (2001), through the construction of a 'community of practice' in which members learn by exchanging their Good Practices (GP). According to these researchers, the exchange of GP entails the exchange of skills and the implementation of 'good working knowledge' generated by one section of a company and taken on by another. The concept of community thus becomes the basis for diffusing knowledge between different actors and allows the learning process to move from a local to a more global, organizational level. By organizing this community of practical knowledge, managers can surpass the sticky/leaky dichotomy (Von Hippel, 1994) (tacit and sticky knowledge/explicit and diffusible knowledge) pertaining to knowledge that is to be codified and indexed, and thus overcome the resistance and tensions that exist within the organization. For this to happen, the objective of the standardization process should be oriented towards a common organizational interest, made possible by a participative managerial style that is deeply involved in the process of codification and its monitoring. With this in mind, we argue that these communities cannot be managed by "Leadership", as the ISO 9001 standard prescribes, but rather by a "Communityship". The "Communityship" corresponds to a type of power that is divided between several individuals according to their capacities and knowledge, interconnected by a common objective: to optimize the performance of everyone and to create new value that can be added to the organization's cultural heritage (Mintzberg, 2008).

2.3 Tensions in the implementation of standardization rules

By involving employees in the management of their own activity system and by confronting them with the inconsistencies between their attitudes (reluctance) and the objectives of the organization to which they belong (performance), three paradoxes may be overcome (Lewis, 2000): the learning paradox, the organizing paradox and the belonging paradox. The learning paradox concerns the opposition between the need for stability of learning and the opportunities of taking on new knowledge in order to be creative. In the organizing paradox, the management seeks to involve its employees in a process of change, even if they are resistant and losing confidence. With regard to the belonging paradox, employees question their identity in relation to others by seeking to understand how to integrate into a group and preserve one's identity, knowledge and skills. These paradoxes appear in the organization as emotional strain combined with cognitive tension, creating anxiety which prevents the employees and the company from benefiting from the store of knowledge that the organization possesses and which could be used to further its objectives.

For our part, we shall distinguish between three paradoxes surrounding the implementation of a standard. The first is highlighted by the "interpretative tension" attributed to the contradiction between the roles of conformity and exploration which are assigned to a standard. The second is related to "confrontation tension", which emerges once external expert knowledge converges with routine organizational or practical knowledge, which is often tacit and difficult to change. The third paradox is anchored in the "tensions of codification". These tensions manifest around the requirement to document in writing the daily working procedures of actors to capitalize on the Good Practices to diffuse.

In this paper, we are particularly interested in the third paradox, that of knowledge codification, which emerges from the requirement of "written procedures". The objective is to identify and codify the local Good Practices in order to render them diffusible and replicable throughout the organization. These Good Practices can become Best Practices if they are shared by an entire industry or given sector, beyond the boundaries of the company.

The quality approach conveyed through the ISO 9001 standard implies the codification of knowledge and its formalization in a documented system, the Management Manual. This work is only valuable if this knowledge is shared with other parties concerned with improving opportunities for learning and developing skills which create new capacities within the company (Zander & Kogut, 1995 ; Szulanski , 1996).

According to Kim (1993) the learning process, that is to say the acquisition of knowledge and skills, is individual when it allows for an improvement in the operational capacities of an individual, and it becomes organizational when mental models of individuals are made explicit and are actively shared. Organizational learning is generally reserved for situations in which the elaboration or implementation of a new competence involves several members of the organization. This new competence entails a conceptual change in the organization. Kim observes that the passage from individual learning to organizational learning is a form of gathering fragmented knowledge among individuals via experiments whereby employees and managers test and learn together. According to Kim, this is the kind of experience that allows for change in the mindsets of individuals and which aligns the objectives of a practice, from an individual level to an organizational and conceptual level (Kim, 1993).

This experimental approach designed to stimulate a group that is learning to create new meaning and value in its activities has been widely debated in the literature as an approach that transforms tensions associated with the implementation of new rules in a system of established knowledge and relationships. In "Creative Experience" (1924) Mary Parker Follett advocated the possibility of making a creative experience out of the implementation of new 'expert' rules. For Follett, the leadership must show its employees that every project to be followed and experienced is a 'law of the situation' and therefore requires the participation of everyone. It must encourage them by giving them the opportunity to enhance and develop their skills, inviting them to 'live' a project as an experience which only becomes creative with the integration of their activities and the coordination of their tasks. It is through experience that practical knowledge is contextualized (Follett, 1924). According to Follett, experience facilitates the understanding of expert rules, which are often abstract, and helps to apply them to practices in order to improve them with new values.

Thus, the stage of codifying practices is a key stage in any quality management system and it necessitates a participative management that will understand the tensions and manage them. The literature surrounding the theme of the management of paradoxes distinguishes three ways of dealing with paradoxes: "*acceptance*", "*confrontation*" and "*transcendence*". For Schneider (1990), "acceptance" consists in learning to live with a paradox in a group of individuals working together and individually to achieve a global performance. This form of paradoxical cohabitation offers a certain freedom of action, a personal autonomy, which prevents debates, because it is 'dominated' by a leader of the group. For example, in a quartet, the musicians who wish to dominate the music individually must always focus on the global performance, which in turn remains dominated by the baton of the orchestral conductor.

"Confrontation" implies a discussion that attempts to make sense of apparent contradictions. It enables the construction of a new working framework which surpasses contradictory individual rationale and emotional tensions to arrive at cognitive tensions (Lewis, 2000). According to this author it is the management's role to know how to focus on cognitive conflicts and avoid emotional conflicts, paying attention to the valuable crossover of diverse knowledge and skills and reducing the power imbalance between managers and employees. Josserand and Perret highlight that one of the great difficulties managers face is their permanent confrontation with situations where emotional and cognitive conflicts are tightly interlinked. They must then direct exchanges to deal with the concepts and ideas held by individuals and not with the individuals themselves (Josserand & Perret, 2003). For Hatch & Ehrlich (1993), the use of humour is a 'low risk' approach in the management of paradoxes by confrontation. In certain circumstances it reduces emotional intensity, thus distinguishing between emotional tensions (personal) and cognitive tensions (organizational). In this way, the confrontation becomes an opportunity for fostering ideas and new solutions likely to bring about cognitive 'jumps' within the organization (Josserand & Perret, 2003). Brown & Eisenhardt (1998) assert that certain experimental products elaborated freely by the company could resolve paradoxical situations. For Kanter, Stein & Jick (1992), the firm's ability to resolve paradoxical situations is reinforced by the existence of a portfolio of innovative experiments, made up of random local innovations.

The third way to deal with paradoxes, the "transcendence" approach implies the capacity to think of the paradox in a '*second order thinking*' way, as opposed to '*first order thinking'*. In the latter case, the solutions found represent a part of the original problem, whereas 'second order thinking' allows managers to perceive the reasons behind the contradictions which place the actors of the same organization in opposition to one another. In this situation, managers should be creative in order to benefit from such disturbance, involving executives and employees in a cooperative framework thus constructing an interpretative framework for the tensions that hinder learning and development.

Even if the issues associated with the existence of paradoxes and tensions in the functioning of organizations have been sufficiently discussed in the literature, there exist few interpretative guides for organizations dealing with such tensions and questions - guides that might constitute tools for exploring, analyzing and understanding this question. We argue that the research conducted by Engeström on activity systems seems to represent an exception in this field. Indeed, through his research this author has developed an interpretative framework for the tensions that emerge following the interaction between a tool, the actor and the objective to be reached (Engeström, 2001, 2015). This led him to the formulation of a key concept: expansive learning. In what follows we shall discuss this work.

3 The Activity System Theory and Management of Paradoxes

In an attempt to analyze the management and understanding of a paradox, Cameron & Quinn (1988) and Argyris (1993) assert that this task requires more than a definition of its characteristics. It necessitates a tool or a framework to explore it, not for eradicating tensions but for making sense of the contradictions. It is in this sense that the words ‘management’ and ‘manager’ take on their original meaning (manager of tensions) beyond the classic Plan Do Check definition of the control (Handy, 1994).

In order to understand - and make visible - the tensions inherent to our focus of research, we have taken Engeström's (2001, 2015) activity system as our model. The goal of this model is to better understand the notion of organizational learning via a mediating artifact that generates disturbances of practices and among practitioners. It shows how an artifact (management tool) interacts with subjects and formal and informal practices (rules) in a context that is wider than the organization in question (community), in such a way that new concepts are elaborated through expansive learning and the understanding of tensions that arise gradually as the tool is implemented.

Engeström's model of activity system and expansive learning (2001) builds on and completes the activity theory initiated by Vygotski (1985) and Leont’ev (1981). According to his model, the 'subject', or any actor assuring the learning experience drawn from the artifacts (tools) or rules (formal or informal, explicit or implicit), which consolidate relationships according to a precise division of labour, interacts with his/her 'community' or the sum of individuals working together to reach an object, that is to say a common objective (Figure 1). The concept of community serves to group together the collaborators that Engström qualifies as a ‘*knot*'. Through their integration, or ‘*knotworking'*, a new form of organization emerges with the aim of accomplishing collaborative work and a co-configuration of the activity system.

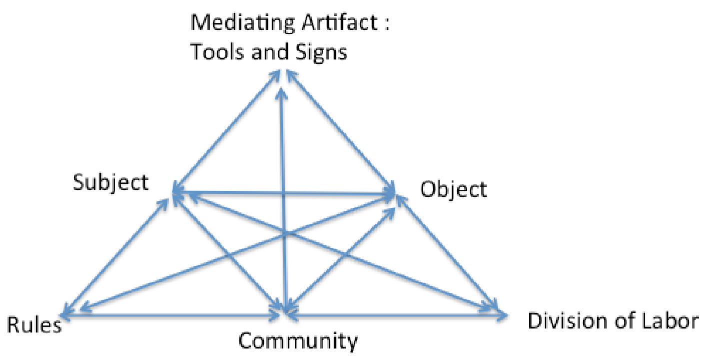

Figure 1. Yrjö Engeström's activity system model (2001).

In this model, the activity equates to a notion of practices encompassing the acts, discourses and attitudes involved in implementing an idea, concept or tool. When the aimed-for object differs between an individual and his or her community, or between a practice in progress and a new rule, this produces tensions, conflict or "disturbances", which are responsible for the evolution of the system and the object to be attained. This evolution leads to expansive learning which takes a cyclical form of several phases of learning, where successive concepts are elaborated as new solutions to the disturbances produced (see figure 2 for the case of Danone below). The term 'expansion' signifies a transformation of the scope of the object, related to an expansion of the knowledge and skills of the individuals. Under this model, cognitive acts can only be understood from a social perspective whereby collaborators commit jointly to a creative process that centers around the same object which is sufficiently significant for their creative potential to come into effect (Engeström, 2001). The theory of expansive learning is based on a learning process that moves from partial to total learning. It is a method that allows us to theoretically trace the logic behind the development of an intention or an objective hidden behind an activity, as well as the history of its formation via the emergence and solving of contradictions inherent to the system (Engström, 2015). Engeström stresses that in a model of collective system activity, individual and group actions are integrated into a collective activity system where every action is oriented in an explicit or implicit manner towards the same object; and these actions are characterized by ambiguity, surprise, interpretation, *sense-making*, and the potential for change.

We have chosen this model for two complementary reasons. On the one hand, it reveals the interaction of the three components of the management tool described earlier. The interpretation of the significance of the mobilized tool (the artifact), the management style that will make use of the disturbances that arise, and the reductionist view of knowledge and the parties involved in the implementation of a rule, will all three gradually evolve from the deployment of the tool and from the emergence of disturbances that create new concepts. On the other hand, this model, known as "learning by expanding" shows how we can move from exploration to innovation by a learning process that occurs in the expansion of the object to be met (fixed as the objective of the process) and of the system of collective activity.

In order to illustrate the application of the expansive learning model in the context of the codification and diffusion of good practices, we mobilize a case study concerning the French food product entreprise, Danone. This company has undertaken an innovative experiment, known as the "NetWorking Attitude" (NWA) where good practices are exchanged in a festive atmosphere created in a marketplace-like event. We had access to the case study through the publication made by it creators (Mougin and Benenati, 2005), (Rolland, 2012) and (Edmondson & al., 2008) and we had the opportunity to conduce a direct interview of one of them.

4 Operational Illustration of Expansive Learning Model: The Danone Case

4.1 The context of Danone

Danone defines itself as a 'Glocal' multinational, which draws its resources from the paradox of "integration-decentralization" and from the headwinds faced by a multinational firm. These headwinds push the multinational to go beyond the market demands by anticipating competition. For Franck Riboud (CEO), Danone's risks are its limits. Danone is smaller than its competitors (Nestlé and Unilever), and therefore does not aim to compete with them in mass production; it rather intends to be the fastest to access markets with new products, services and values. It is for this reason that Danone invests in the management of its knowledge and skills, scattered as they are between factories and individuals throughout the entire world. Its primary objective, to maintain it place among the world market leaders, is to collect its specialized but fragmented knowledge in order to gain a rare competitive advantage which is difficult to imitate and which is the driving force behind its own innovations.

Danone is a world leader of the food industry, particularly in health foods. The global context around the production of the group constitutes the starting point of the implementation of a common management system via the standards ISO 9001 (for quality management) and ISO 22005 (for the food security of products). These standards allow the use of a common language to all the parties involved and structure practices on a worldwide scale. This has been the case since the 1994 version of the ISO 9001 (Berget, 2008). Promoting and energizing organizational learning to stimulate creativity and innovation across all of its units is a fundamental objective of the group. From this perspective, the codification of good practices to be transmitted to all of its subsidiaries across the world proves to be a vital but difficult operation: on the one hand it requires the participation of the largest possible number of actors, and on the other hand it needs an appropriate dissemination tool. To encourage all of its employees to collaborate, the business has invented a participative management of its own. In order to reinforce their feeling of belonging to the company and the image and culture of the group, the group has created an identity for its collaborators: they are 'Danoners' who work in a 'Danone Community' in a 'Danone Way' organized around 'storytelling'. These "nice stories" are reserved for the group, they are Good Practices to recount and then exchange. In terms of its attitude towards management, Danone's objective is to transform the group's values by the reinvention of its relational knowledge, which is spread between the different parties scattered around the world (Danone, 2013).

4.2 Danone's approach to the codification of practices and knowledge management: application of the activity system model

The desire to manage the paradox of maintaining autonomy while integrating entities on an organizational and cultural level led two directors of the group, Franck Mougin, the general director of human resources, and Benedikt Benenati, director of organizational development and knowledge-networking, to imagine a new attitude towards organizational knowledge management: the NetWorking Attitude (NWA). It consists in networking Good Practices that have proven successful in an activity system. We shall detail below the successive stages of development in this model, firstly by specifying the primary requirement of the system and the object targeted in the implementation of a tool (concept 1) and the disturbances or conflicts which arise in putting the concept into action. These disturbances are instrumental in creating a new Concept 2, and then another Concept 3 in a cycle of organizational learning founded on the individual knowledge of the group. The sentences in italic are taken verbatim (translated) from the developers of the tool, Mougin & Benenati, in their account of this experiment (*Danone se raconte des histoires*, 2005) and in the article written by Edmondson & al. (2008).

Contradiction in the group's management system: Integration/Decentralization.

System requirement: Continuous improvement of quality management by avoiding a pyramid approach to solving problems: "*When a front line manager encounters a problem, he turns to his boss, who in turn consults his own boss, and so on, until the point where the heads of different entities discuss the manager's problem in a transversal manner. The question descends to the level where another entity finds a solution, and the latter has to follow the reverse course and climb back up the hierarchical pyramid of this entity before redescending in another.*"

<u>Object to be achieved</u>: To exchange GP between the different divisions without consulting a pyramid model of management.

<u>Concept 1</u>: Rely on the ERP to manage the communication across business units

This tool consisted in setting up files, databases and a network for managing the Good Practices of the managers of the group; it incorporated 144 GP.

<u>Contradiction (a):</u> "*This virtual system did not work, the actors did not engage in exchange, and the database was not used. Scaling complicates the problem, takes up time and leads to online loss.*"

Another tool had to be found which reconciled the contradictory objectives of the management of the company by creating a new concept based on behavior management.

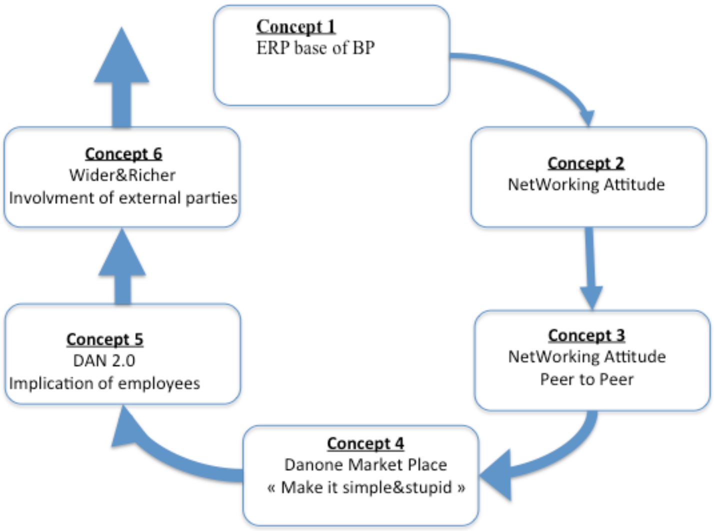

Figure 2. The cycle of expansive learning applied to Networking Attitude at Danone

Concept 2: the Networking Attitude, NWA

Object 2: Direct discussion in meetings to speed up the sharing process and the circulation of knowledge and Good Practices in different units, functions and countries.

Contradiction (b): *Bosses were reluctant to let their teams engage in direct discussion.* Contradiction (c): *The group consists of 90,000 people, therefore direct contact in resolving problems and finding solutions is impossible.*

Concept 3: Networking Attitude *'peer-to-peer'*, only between managers

Object 3: *"The front line manager must demonstrate the reflex to consult his colleague rather than his boss". This means reaching the 8,400 front line managers of the group.*

The tensions or disturbances under this concept are linked to a pitting of skills between managers. A case of '*double binds*' (contradictions (d) and (e)) where the actor is confronted with two choices which both seem undesirable.

Contradiction (d): The manager's anxiety about becoming redundant and losing his or her skills: *"If a collaborator transfers an efficient practice that he/she has developed, he/she risks losing control of it and of no longer standing apart and being indispensable. This also harks back to the syndrome "not invented here".*

Contradiction (e): Fear of being judged incompetent: *"Adopting another's solution signifies that I do not know how to resolve the problem myself. The fear is shared equally by bosses; if their collaborators find solutions by consulting their colleagues, they will no longer be useful".*

Concept 4: "*Make it simple and stupid*" Danone Marketplace of Best Practices

Object 4: Direct, improvised and fast exchanges of Good Practices between specialists concerning good techniques, to forge a community of professionals.

The developers of the project justify their choice: *"When instructions are too sophisticated, people will not understand them, and it is therefore necessary to be intelligent to give simple* *instructions. Simplicity is complicated, and therein lies the art of the manager; and that is how the authority of the management is felt, by simplifying a rule that must be appropriated to become a standard of attitude and practice."*

The *Danone Marketplace* is an organized bazaar. It stems from the classic idea of a market in which one does not exchange products but Good Practices that have proven successful in the units where they were created. The actors (front line mangers) of every department (Research and Development, food security, stock management) in the three core businesses of the group (dairy products, water and biscuits) appear unexpectedly in a meeting in an informal manner, in disguise and for a short time to propose Good Practices for sale. *The set-up of 'the market' was conceived around a theme (Provencal-style market, Hungarian market, Star Wars, the American West, etc.) and the 'givers' prepare by rehearsing a presentation that must not exceed ten minutes. At the presentation, givers are in disguise "in order to do away with the hierarchical ranks and get over inhibitions"* and the 'takers' are given the *"little book of good practices", a reference document of the codified Good Practices to be consulted on the spot.* These GP are like short stories told in 30 seconds. Seven checks are distributed to the 'givers' to symbolize the act of payment (the transaction) and the duty of the 'giver' to implement the Good Practice that has been sold/bought. *"The agent keeps the counterfoils in order to monitor trade within the community and eventually recount beautiful stories".* The reference document of GPs is the mediating tool between the subject, object and the community. The concept was proposed with the idea of forging a community of jobs. *"We should sell the idea by explaining things in a simple way, almost simplistic".* "When the 'taker' has met the 'giver' and an exchange has taken place, beneficial results are obtained in terms of time gained and errors avoided; this becomes a '*nice story'". "The specialists exchange their techniques with the same vocabulary and in-depth understanding".*

Edmondson & al., (2008) have highlighted a tension between the management who wish all of their employees to participate in this approach and a group of people who are reluctant. "*Some still believe that the contribution of non-managers to total performance does not merit including them in networking activities and that we will not gain what we spend to make it happen*", but Mougin believed that all 90,000 Danone employees could benefit from the Networking Attitude to share good practices. Mougin had tested this belief with a marketplace for assistants that worked well, with some assistants claiming that it was the first time anyone had asked their opinion. *"This is about empowerment and appraisal",* said Benenati.

Therefore, a new concept was born out of this tension which widened the scope of the peer-to-peer NWA for all Danoners, the *Who's Who*. Launched in 2007, this concept was a virtual tool in the form of a company directory in which every one of the 90,000 individual employee records contained a tick box (*I'm happy to share*) which allowed employees to look for a solution to a specific problem with key words. In no time, this concept proved inappropriate, because it was entrapped by its own mode of functioning, based as it was around the key words used for seeking a competent person: *for example, the word "diversity" would refer you to all the people who had written this word in their profile. This intranet program was not judged to be useful and it failed* (Edmondson & al., 2008). Subsequently, this opened up another discussion to address questions about the relevance of making this space/tool available for all the employees of the group and how this should be done.

<u>Concept 5: Dan 2.0, wide expansion of the object, for all employees of the group</u>

<u>Object</u>: To reach more employees via the exchange of their GPs - from learning between managers to organizational learning.

Dan 2.0 is a new program of organizational change which requires a strong commitment from

the management to support the 'democratic principles' of this participative managerial philosophy, qualified as "user centric" (Rolland, 2012). Each employee is considered as potentially possessing knowledge that could be the source of a competitive advantage. The Marketing Director, Fabien Razac, declared that *"Danone's expertise is fragmented between its employees, and the act of grouping them together allows for the formalization of personal learning*" (Edmondson & al., 2008). In effect, this new concept modifies the object by maximizing sharing and optimizing knowledge on a global scale. The advantages of the expansion of the object and activity are manifold. The exchange of Good Practices enriches the knowledge of employees and improves their performance and autonomy in the process of problem-solving. This practice allows for a strategic alignment between the managers and employees across all units. The first drawback of this system lies in the "language" in which Good Practices are exchanged. Danone operates in 140 countries and language barriers may reduce the wealth of the data to be capitalized and demotivate certain employees from codifying or learning knowledge. A second disadvantage can be linked to the time factor. Employees must dedicate a certain amount of time to codify their knowledge in a simple form which is clear and accessible. The developers of the project pointed out a contradiction, namely that up until this point knowledge is only shared and that a Good Practice today may not be one tomorrow. The tool must be open to the creation of new knowledge and innovation.

Concept 6: Peripheral expansion of the object, "Wider & Richer"

Object: To involve all the parties concerned in the project (suppliers, retailers and consumers). The purpose of the expansion of the object is to build external relationships, beyond the organizational frontiers, thus rendering the objective fixed at the start richer and more complex (Edmondson, 2008). This collaboration gives the employees of the company access to information about products (*on-shelf product availability*) and consumers (their needs and expectations) through the exchange of information and Good Practices that improve general performance and consolidate lasting relationships, thus ensuring the group's advantage in its industrial sector. Giving consumers the opportunity to express themselves allows the group to become reactive and fast when responding to the new needs of the market, before competitors do so. This new concept boosts the activity and reactivity of the group and develops the sense of unity and uniqueness that underpins the culture of the group.

Our examination of the NWA at Danone shows how a tool can gradually be transformed and at the same time transform the identity and knowledge of the actors during the process of its diffusion. This transformation is the result of successive learning that reduces constraints, by playing on the facilitating principles in the adoption of a management innovation (Ansari, 2010). This happens via divisibility (a small-scale trial at the beginning which then takes on wider dimensions) and the simplification of its complexity (inventing themed markets with disguised participants). The NWA has made GPs accessible to 5,000 of the 9,000 managers worldwide. Between 2004 and 2007, employees exchanged 640 GPs.

The involvement of the management, notably through its liaison with the developers of the concept, not only consisted in making its presence visible in certain marketplaces, but also in monitoring the transaction and widening its impact to reach other units and the organizational performances that they generate. Danone has published the results of exchanges in GPs at Lu France, showing that, thanks to the exchange of GPs between 2003 and 2006, the number of incidents linked to problems of food security has decreased by 25% (Edmondson & al., 2008).

The social interactivity in this system constitutes a precondition of the internalization of knowledge on the part of the actor and the externalization performed by the actor towards the object. This externalization of knowledge and exchanges in GPs have enabled the group to innovate in the areas of working practices, behavior and products: *In a "little book" in Brazil, a story entitled "If time is not on your side" describes how the Brazilian marketing team helped the French marketing team to introduce a 0% fat dessert, the 'Taillefine', through an exchange of Good Practices.*

Essensis, the yogurt that 'nourishes skin from the inside' is the result of a centalized effort (three local ideas), which was then decentralized (by calling for a collaborative project between several teams in several countries). Thanks to this collaborative work 'Essensis' appeared on the market within 7 months (Edmondson & al., 2008). This innovation is linked to the pooling of separate functions and talents. It embodies the principle of 'cross functional teams', highlighted by Juran (1998) as the factor which makes possible an alliance between the standardization of practices and innovation and which manages diverse sources of knowledge to steer them towards a common objective.

5 Discussion and Conclusion

The analysis of the codification of good practices within an organization, in view of their diffusion via the company's activity system, has allowed us to highlight the tensions and paradoxes that arise in practice during the implementation of a management tool designed to aid this diffusion. Our examination has also brought to light the importance of a management philosophy oriented towards managing these paradoxes. The utility of the tool (object) evolves as it is integrated into practices and diffused throughout the organization, internally then externally. These practices are the meeting point of the tool with its users, where a mutual transformation begins to render the change, and the successive training that follows, 'socially acceptable'. For the tool, this transformation is evident in the expansion of its object (exchanges of Good Practices leading to product innovation) and for the actors in the appearance of emerging practices (dialogue, communication, collaboration and co-production). The use of the tool and the disturbances of the system make it possible to surpass conformation with the rule (exchange of Good Practices) and move towards exploration and innovation, via collaborative practices. Thanks to these practices of co-configuration and co-collaboration, the concept of k*notworking*, that lies at the core of Engeström's activity system model, is largely fulfilled.

The activity system has represented a framework which renders visible the learning process, the actors who learn, what they learn, how they learn and why. The organizational requirement to transform the achievements of an individual's learning (a front line manager) into collective learning (between managers) has been confronted with another need (new object): to render the learning organizational. The expansion of the object has made it possible to introduce knowledge into a collective activity system, but it also clashes with another activity system outside of the organization's boundaries, where new contradictions emerge and another cycle of learning is set in motion. Exposing organizational knowledge to the concerned external parties confronts the group with another paradoxical injunction: not involving the concerned external parties means depriving the company of useful knowledge for innovation, and yet doing so can lead to a 'leak' of the company's expertise and its transferable knowledge ('leaky knowledge'), beyond the perimeters of the organization and towards its competitors. However, this is the driving momentum behind an activity system which evolves by re-conceptualizing the motive for change through the willingness of individuals to make it happen. The case under study shows that change operates in two ways: on management side, who motivate, and on actors side who gain confidence and develop a willingness to change and reconfigure their practices. Through such willingness, actors have gone further than they have been asked and have surpassed the contradictions surrounding their practices. In the process of paradox management known as NWA, managers used three levers to deal with the 'paradoxical considerations' which are at the heart of the problem of organization theory:

- An "autonomy under control". Even in the marketplace there is a facilitator who checks the coherence between the buyer's need and the seller's Good Practice. His or her role is to assure that the right solution has been sold to the right person at the right moment and in an adequate format.
- An incentive to "specialize in order to become more flexible". Through the involvement of all collaborators in the process of sharing, Danone encourages all of its employees to participate in this innovative experiment. But for this participation to be possible, a Good Practice must be standardized so that it can be diffused.
- Founding the "objectives of innovation for products/services on the stability of Good Practices". The combination of Good Practices diffused across different units creates cross-fertilization and forms a catalyst for product innovation, launched as solutions/services (beauty/health).

We may conclude that paradoxical leadership proves vital in the NWA for overcoming the different tensions that arise. For Lewis (2000), a manager who thinks in terms of paradoxes has an influence on the thinking of his/her collaborators and motivates them to examine together the tensions that hinder the development of their system: the paradox of organization has been assured by autonomy and commitment. Actors have deliberately committed to an experiment which may be likened to a coin with two sides, one for monitoring/control (the key to efficiency through standardization) and the other for autonomy and exchange (the key to creativity).

According to the schema of Engeström's model in the NWA, actors are not neutral and neither is the tool with regard to the learning process - it is developing. The knowledge responsible for this expansion is not contained within the artifact, but in the schema of the actors. The value of the tool lies in the evolution of concepts, from a technical tool for transferring Good Paractices towards a tool of social interaction whose effects are only evaluated in practice. We would define this interaction as the moment when "actors seize the tool", engaging in a reflective way and pointing the tool in the right direction for improving their practices, knowledge and skills. This moment is followed by another moment when it is "the tool that seizes the actors"; at the point of its implementation, it destabilizes their work environment by dictating, via its artifact, new operational schemes.

The codification and diffusion of Good Practices constitutes one of the pillars of the ISO 9001 standard. The NWA experiment at Danone, even if it was not initiated within the framework of implementing a standard, in our view remains a very good empirical illustration of the manner in which a management tool oriented towards GPs is implemented in an organization. This case has highlighted the influence of, and the interdependencies between, the components of a management tool as defined by Hachuel and Weil (1995). The capacity of the tool to ensure that practices conform to its technical foundation is limited in the case of Danone. The philosophy of management plays an exploratory role in dealing with paradoxes. These paradoxes are intangible phenomena that must be identified and whatever is inherently conflicting needs to be interpreted. Through the use of humour, the developers of NWA have succeeded in identifying the tensions that hinder actors from adhering to the process of sharing their GPs: the anxiety linked to a loss of skills, the fear of being judged incompetent, and conflicts of belonging, where a local group has to exchange what it holds most dear with other people they have never seen.

Finaly, we would propose to generalize our conclusions about the codification and diffusion of good practices in an activity system to the case of management systems in general and the ISO 9000: 2015 standard in particular. Indeed, in the light of what has been described previously, the process of implementing standardization principles appear to be more like the management of contradictions and paradoxes to go beyond then than the management of stability and conformation within a system. In such a system, top management and managers hold the keys to creativity for motivating employees and revealing their skills to address the paradoxes of management.

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Plugs and Socket-Outlets: Pet Peeve of International Travelers and Standardizers Alike

Hans Teichmann

Lausanne, Switzerland
teichmann.hans@bluewin.ch

Abstract: *The present state of the standardization of plugs and socket-outlets is unsatisfactory. The confusing diversity of these devices is due not only to technical constraints, but also to historical/political developments across the globe. In 1933 the International Electrotechnical Commission (IEC) set up its Technical Committee (TC) 23 to deal with the standardization of "electrical fittings". When the plethora of the plugs and socket-outlets in use became nonetheless an increasingly untenable problem, in 1970 Subcommittee (SC) 23C, "Worldwide plug and socket-outlet systems" was created (in the meantime disbanded). It took about two decades until the three parts of IEC Standard 60906 could be published - unfortunately too late. IEC's actual procedures would prevent such failures. The popular view that the simple replacement of all existing plugs and sockets-outlets - regardless of the associated domestic wiring installations - would solve all related problems is wishful thinking: Once a mains power system is in use and the equipment using it is widespread, changing to IEC's "Universal standard plug type N" is a drastic and overly expensive measure. Nevertheless, as of this writing Brazil and South Africa are successfully phasing in the IEC 60906-1 plugs and socket-outlets.*

1 Introduction

The purpose of this study is *not* to present technical details or to suggest new technical solutions. Because, however, the presently available references (such as IEC 1986; IEC 2009; IEC 2015,a; IEC 2015,b; and IEC 2015,c) do not provide a coherent picture of the issue of plugs and socket-outlets, this review is intended to *help non-experts in the field* to *better understand specific underlying problems.* As regards *academic standardizers* who may not be interested in actual technical aspects, they are introduced to the *true nature of the problems and constraints* in IEC's, ISO's and ITU's *global technical standardization work.*

Alternating current (AC) power plugs and socket-outlets are the devices that allow electrically operated equipment to be connected to the primary AC power supply (or "mains electricity") in a building. Unfortunately, in different countries the *mains electricity systems* differ in several respects. These elements are the voltage rating, current rating, wiring as well as - particularly eye-catching - the shape, size and type of the plugs and socket-outlets (see Annex A). Today there are approximately 20 types of plugs and socket-outlets in common use around the world, and in addition many obsolete plug and socket-outlet types are still found in older buildings (Wikipedia, 2015,b). "Why are there so many types of plugs and socket-outlets? Why isn't there a *single type* that could be used everywhere?" This is a recurrent refrain, particularly among frequent (and frustrated) international travelers. The plug and socket-outlet types used in each country are set by *national standards*, most of which are listed in IEC Technical report (TR) 60083 (IEC, 2009). Contrary to common popular allegations, the IEC is fully aware of the pending problems (IEC, 2015,a).

2 Historical background

2.1 Founding of the IEC

In 1904 at the World's Fair in St. Louis scientists and engineers from around the world realized for the first time that *standards for electrotechnology* were urgently needed. In fact, the exhibits that occupied the *Palace of Electricity* not only required electricity of numerous different voltages, but also DC or 1-, 2- or 3-phase AC, with many different frequencies and variations of connectors and plugs. Scientists realized that they needed *common units, terminology and symbols* to build on each other's research, and to facilitate the development and roll-out of innovations. For these reasons the IEC was founded in 1906 (Teichmann, 2001).

2.1.1 Origin of the diversity of electric power distribution systems

The system of *3-phase AC* electrical generation, transmission and distribution was developed in the 19th century by Nikola Tesla, an outstanding Serbian engineer and scientist who had emigrated to the US, as well as by George Westinghouse and others (Wikipedia, 2015,a). The famous inventor Thomas Edison, on the other hand, developed direct current (DC) systems at 110 V; these systems were claimed to be safer in the battles between proponents of AC and DC supply (Jäger, 1996). Edison envisaged a DC power supply based on thousands of "neighborhood generating plants" supplying low-voltage electricity. The problem was that DC power could not be transmitted much further than one mile without serious transmission losses (Adkins, 2009).

The conventional *carbon filament lamps* for lighting were supplanted when metal filament lamps *of higher voltage capability* became feasible (one of Edison's pioneering and best-known inventions). It was therefore a logical step that, in 1899, the *Berliner Elektrizitäts-Werke* decided to greatly increase their distribution capacity by switching to 220 V nominal mains voltage. That way, the company was able to offset the cost of converting the customer's equipment by the resulting saving in distribution conductors cost. This system became the model for electrical distribution systems in *Germany and subsequently the rest of Europe*: The 220 V system became common. *North American practice*, however, remained with voltages near 110 V for lamps (Wikipedia, 2015,a).

In the US at the end of the 19th century, Westinghouse Electric was the first company to buy Tesla's patents on power transmission and decided *on 60 Hz.* The AEG company in Germany, on the other hand, decided *on 50 Hz*, eventually leading to the world being mostly divided into two frequency camps. Most 60 Hz systems are nominally 120 V, and most 50 Hz systems nominally 230 V. A significant exception is Brazil, which has a synchronized 60 Hz grid, but both 120 V and 220 V as standard voltages in different regions of the country.

2.1.2 Initial low significance of cross-border compatibility

When electricity was first introduced to households at the end of the 19th century it was mostly used for lighting (IEC, 2015,b). For some decades all electric devices had to be *patched directly* into a house's wiring (plugs and socket-outlets had not yet developed). However, with the increasing spread of labor-saving, electro-domestic appliances in the early 20th century, manufacturers needed to find means other than to connect them *via a light socket* to the electricity supply. For this reason *electric plugs* made their appearance. This is the point where the present problem of plugs and socket-outlets started: In each country manufacturers developed their own type. This circumstance was not taken as a major problem because at that time only a small percentage of people were travelling across borders, and because their electric devices were generally not portable. Hence *country-to-country compatibility* did not really matter much.

2.2 Failed attempts to standardize plugs and socket-outlets

In 1933, IEC's Technical Committee (TC) 23 was set up to deal specifically with the standardization needs of "*electrical fittings"*. However, the committee's work took a very long time to commence (IEC, 2015,c). During World War II plugs and socket-outlets were understandably far from most people's concern. Work on domestic plugs and socket-outlets got finally under way at a meeting in October 1947. At that time European work had already been undertaken by the CEE (International Commission on Rules for the Approval of Electrical Equipment), and IEC/TC 23 discussed a possible cooperation in the field of "Unification of the International Standards relating to sockets-outlets, plugs and connectors".

The existing CEE work led to the first publication of IEC/TC 23 in 1951. In essence this report was simply a selection of the most widely used plugs and socket-outlets in Europe, excluding the UK and Ireland. At this point the IEC as a whole, and in particular the experts participating in TC 23, realized that there was very little chance to still achieve agreement on a common standard on plugs: Over the years so many different plug types had been introduced that even in a limited regional area like Europe success of standardization was highly unlikely. IEC/TC 23 issued in 1957 its Publication 83, *Standard for plugs and socket-outlets for domestic and similar general use.* Rather than an International standard, this publication was a catalogue of existing national standards.

In the early seventies, IEC/TC 64, *Electrical installations and protection against electric shock*, was formed and it was inevitable that, in its consideration of domestic wiring installations, it would face the problem of the plethora of plugs and socket-outlets in use. This provided the IEC with further impetus to find *a global solution* or, at least, attempt to reduce the number of existing varieties. With this perspective in mind, IEC created in 1970 its Subcommittee SC 23C, *Worldwide plug and socket outlet system* (IEC, 2015,d).

3 IEC's universal plug and socket-outlet system

3.1 Tedious standardization process

Its first draft of a universal system proposed *all flat pins* and this type was pursued for many years. At the voting stage, however, many of the IEC National committees expressed themselves more in favour of a *round pin* solution. The other serious problem encountered was in trying to find a unique solution for 125 V and 250 V distribution systems. After long discussions, SC 23C came to an acceptable solution, the so-called "*IEC universal standard plug type N*", which was finally published in 1986 as International standard IEC 906-1 (now IEC 60906-1) for 250 V installations using round pins (IEC, 1986), and in 1992 as IEC 906-2 (now IEC 60906-2) for 125 V installations using the familiar US flat pin design (IEC, 2011). An important detail is that IEC 60906 is a so-called "flawed" standard. This means that any country involved will have *to make specific adjustments* in order to ensure the necessary compatibility.

At a later stage, CENELEC was put under pressure by the European Commission to develop a harmonized plug and socket-outlet system *for Europe*. Incredible though it may seem, the *economic consequences* of such a universal system were never assessed. CENELEC took as its starting point the IEC standard of 1986. After much work and many meetings, unfortunately the project had to be abandoned.

IEC/SC 23C was disbanded and its work was taken over by IEC/SC 23B, *Plugs, socket-outlets and switches.*

3.2 Current state of affairs

A major advantage of IEC's standard plug is the following: Thanks to modern injection molding technology, which did *not* exist when most other plug types were originally designed, the type N standard plug is more compact, robust and safe than any other plug/socket-outlet system in the world (World Standards, 2015).

The IEC continues to point out that *internationally agreed standards for domestic plugs and socket-outlets* for the 250 V and 125 V ranges do exist and are available to any country that cares to implement them. But so far only *Brazil* (2007) and *South Africa (*2014) have adopted them (see Annex B). The experience of these two countries is encouraging. It should be noted that many Latin-American, African and Asian countries are still in the same kind of situation that Brazil and South Africa used to be in. They should consider appropriate action.

The following facts should not be overlooked: Besides *technical aspects* (it shall for instance be impossible for a child to put his finger in a socket-outlet and get shocked), also *economic elements* (more local manufacturing and thereby creation of jobs) and *possible export opportunities* (provided that further countries adopt IEC 60906) need to be evaluated.

At present, no revolutionary *technical developments* in the field of plugs and socket-outlets are in progress or expected for the near future.

4 Contributing IEC committees

4.1 Particular features of IEC work

The IEC is one of the three global sister organizations (IEC, ISO and ITU) with the mission to develop global standards. It has been shown that participation in international standardization work is in the best interest not only of the industrialized countries but *of any country,* including the developing countries and even the least developed ones (see Annex C; Teichmann, 2015).

As of this writing, no fewer than 97 IEC TCs and 77 IEC SCs were active. All IEC International standards are fully consensus-based and represent the needs of any nation participating in IEC work. Every member country, no matter how large or small, has *one vote. Over 10 000 technical/scientific experts* from industry, commerce, government, test and research laboratories, academia and consumer groups (rather than *non-technical staff members* of national Standards organizations) participate in IEC's standardization work. It is obvious that large multinational companies or the major industrialized countries have more resources for participation and for influencing international standardization than have less privileged players. – Casual observation of IEC work shows that there is a certain national proudness in place and that most National Committees tend to defend their own traditional technical preferences.

At present Technical Committee IEC/TC 23 and its Subcommittee IEC/SC 23B are directly involved in the standardization of plugs and socket-outlets.

4.2 Technical Committee IEC/TC 23, *Electrical accessories*

Scope

To coordinate the work between the different Subcommittees of TC 23 and with other technical bodies within and outside IEC. To prepare standards for electrical accessories for household and home and building electronic systems and similar purposes, the word "similar" including locations such as offices, commercial and industrial premises, hospitals, public buildings, etc. (IEC, 2015,d; IEC, 2015,e).

4.2.1 Subcommittees

The technical work of IEC/TC 23 is undertaken by its seven Subcommittees:

IEC/SC 23A, *Cable management systems*

IEC/SC 23B, *Plugs, socket-outlets and switches*

IEC/SC 23E, *Circuit-breakers and switches*

IEC/SC 23G, *Appliance couplers*

IEC/SC 23H, *Plugs, Socket-outlets and Couplers for industrial and similar applications, and for Electric vehicles*

IEC/SC 23J, *Switches for appliances*

IEC/SC 23K, *Electric Energy Efficiency products*

4.2.2 Subcommittee IEC/SC 23B, Plugs, socket-outlets and switches

Scope

a) To prepare safety and performance standards for general purpose including switches, electronic switches, etc.

b) To prepare safety and performance standards for switches and related accessories for use in Home and Building Electronic Systems (HBES)

c) *To* prepare *standards for plugs, fixed and portable socket-outlets, fused plugs, socket-outlets for appliances, switched socket-outlets with and without interlock, plugs and socket-outlets for SEL, with a rated voltage not exceeding 440 V and a rated current not exceeding 32 A, intended for household and similar purposes, either indoors or outdoors*

d) To prepare standards for boxes and enclosures for household devices, boxes and enclosures with provision for suspension means, etc.

e) To prepare standards for ancillary products which are related to/incorporated in products covered by a), b), c) and d) (see IEC, 2015,f).

Membership

The membership of this Subcommittee amounts to 37 Participating countries (which obviously include Brazil and South Africa, see Annex B), as well as 14 Observer countries.

Internal technical liaisons of IEC/SC 23B

IEC/SC 3C Graphical symbols for use on equipment

IEC/SC 23E Circuit-breakers and similar equipment for household use

IEC/TC 34 Lamps and related equipment

IEC/TC 72 Automatic electrical controls

IEC/SC 121B Low-voltage switchgear and control gear assemblies

Note: Due to this comprehensive coordination the standards' "fitness for use" is widely ensured.

Prevailing strategic aspects

General: In any country, the *demand for safety, comfort and reliable functioning* of mains power systems is closely linked to its economical and technical development (IEC, 2015,g). In addition, the *ever-growing worldwide trade* entails the need for globally accepted standards.

Market demand: Standards for ensuring the *safe and reliable functioning* of plugs, socket-outlets and switches are required. Since these devices are commonly used *by uninstructed persons,* certification of compliance with internationally recognized standards is essential. Main users of the relevant standards are manufacturers, testing stations, electricity suppliers and installers.

Technological trends: Home and building electronic systems have an effect on the accessories linked to control. Therefore, the ongoing evolution requires the revision of existing standards, in particular with respect to electromagnetic compatibility.

5 IEC publications on plugs and socket-outlets

So far, IEC/TC 23 or one of its Subcommittees have prepared four relevant publications. No further publications in this field are forthcoming at this time.

5.1 IEC Technical Report 60083, 2009: Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC

This Technical report was prepared by IEC/TC 23. It gives information about the systems of plugs and socket-outlets for household and similar purposes, which are used in the IEC member countries. It only contains National Systems which are commonly used in homes and offices. It is therefore limited to systems with AC with a rated voltage above 50 V but not exceeding 440 V, intended for household and similar purposes, either indoors or outdoors. The Report only contains systems for which standards sheets have been published in a National Standard, which may be a National Standard of the country itself or any other IEC member country (IEC, 2009).

5.2 IEC Standard 60906: IEC System of plugs and socket-outlets for household and similar purposes

5.2.1 IEC 60906-1, 1986: Plugs and socket-outlets 16 A 250 V a.c.

Part 1 is an international standard for 230 V AC domestic power plugs and sockets-outlets. It was prepared by SC 23C and conceived as a common mains plug and socket-outlet standard for use in territories with 230 V mains. The current second edition was published in 2009. Although the IEC design is *similar* to the Swiss SEV 1011 plug, *its dimensions* are different.

Note: IEC 60906-1 is a so-called "flawed" standard. In other words, adjustments are generally required for its implementation in a given country.

5.2.2 *IEC Standard 60906-2, 2011: Plugs and socket-outlets 15 A 125 V a.c. and 20 A 125 V a.c.*

Part 2 applies to the IEC system of plugs and socket-outlets rated 15 A 125 V AC and 20 A 125 V AC for household and similar purposes, for the connection of equipment to distribution systems having nominal voltages between 100 V and 110 V AC in so far as dimensional requirements are concerned. This third edition of IEC 60906-2 cancels and replaces the second edition published in 1997.

5.2.3 *IEC Standard 60906-3, 1994: SELF and socket-outlets, 16 A 6 V, 12 V, 24 V, 48 V a.c. and d.c., intended for household and similar purposes, either indoors or outdoors*

Part 3 applies to the IEC SELV (Safety Extra Low Voltage) system of plugs, fixed and portable socket-outlets and to socket-outlets for appliances rated 16 A 6 V, 12 V, 24 V, 48 V a.c. and d.c., intended for household and similar purposes, either indoors or outdoors.

6 Conclusions

6.1 General

Every so often, inexperienced international travellers think that they are the first to discover the annoying problems related to the plethora of plugs and socket-outlets. And in the critics' view, professional incompetence and/or negligence on the part of the IEC may be to blame. Certain laymen even feel that global standardization in general may be a useless endeavor. However, things are more complex. The critics overlook the fact that, *without an appropriate technical infrastructure,* virtually nothing in our modern world would work. They should recognize that the undeniable shortcomings in the field of plugs and socket-outlets are *by no means typical for IEC work:* The vast majority of the commission's projects are brought to a successful conclusion, and usually within acceptable time limits. It is also important to know that *today's revised procedures for IEC's technical work* are designed for preventing such undesirable developments.

Whilst the present study does not develop any fancy academic theories, it does shed some light on *the real nature* of the problems encountered in technical standardization. By the way, participation in standardization is in the best interest *of any country*. Despite their important contributions, most national and global standards bodies around the world share unfortunately an undeserved and disturbing obscurity in public awareness.

6.2 Technical issues related to plugs and socket-outlets

Worldwide many different types of *mains power systems in buildings* are found (see Annex A). This diversity is not surprising because in former times and on all continents, the different countries - and frequently even different regions within a given country - developed their own mains systems without any coordination with their neighbors. This development took obviously place *before* electronics were globalized, and *before* country-to-country compatibility really mattered.

The mains power systems in buildings are characterized mostly by six features:

- Their voltage, frequency, grounding, protection, and related parameter tolerances (five elements which are *generally invisible* to common users and laymen), as well as
- The international traveller's pet peeve, the *highly visible plugs and socket-outlets.*

Evidence suggests that the design of plugs and socket-outlets is tied to the *type of power grid* to which they are attached (that is, the design of these devices is not merely related to the grid's voltage). The popular belief that *the simple replacement of the existing devices* by IEC's "Universal standard plug type N" could solve all pending problems is therefore wishful thinking; the implementation of this method would actually represent a typical "Procrustean solution" (see Appendix A).

6.3 Past hurdles in standards development

The responsible IEC committees are at present TC 23, Electrical accessories and SC 23B, Plugs, socket-outlets and switches. These committees expect at present *no revolutionary developments* in the foreseeable future.

Early efforts to standardize plugs and socket-outlets had trouble taking hold. At a later stage, World War II put a hold to all relevant discussions and the issue was dropped until the 1950s. But at that point countries had most of their infrastructure in place and vested interests were built right into the walls. Most manufacturers had naturally focused on serving *their national or regional markets*. Today, on the contrary, in the *global market* having so many different plugs and socket-outlets is highly inconvenient and costly.

The IEC tried for decades to develop a *universal domestic power plug*, but time and again political issues threw a spanner in the works. In 1986, the commission finally presented its "Universal standard plug type N". But at that time the standardization of plugs and sockets *came definitely too late*: Once a given system is in use and equipment using this system is widespread, any change requires *drastic and* overly expensive measures.

6.4 Present implementations of IEC 60906-1

There are nevertheless two countries where *adapted versions* of this standard are now implemented (see Annex B). The establishment of IEC's plug type N as sole standard in *Brazil* was motivated by the urge to sort out the motley collection of plugs in use throughout the country. *South Africa* is now taking similar action, and other countries with such problems should consider following suit.

The switchover from the existing configurations to the "Universal standard plug type N" is in practice handled as follows:

- *New domestic appliances and electronic devices* are furnished with the *new type of plugs*. The process of phasing out the old plugs is gradual and will take 20, 30 or even more years.
- The actual *change of the socket-outlets* is expected to take a long time: Replacing the existing mains power systems would be too costly; moreover, in the foreseeable future *the existing installations* need not to be adapted.

These considerations lead to a final conclusion: Whilst IEC Standards are actually proposals, most of them gain wide actual usage and acceptance. **The present issue of plugs and socket-outlets may remain forever a pet peeve for both international travelers and standardizers. But it must not be overlooked that global standards in general represent an efficient engine for creating wealth.**

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Annex A: Important features of mains electricity in buildings

Worldwide, many different types of *mains power systems* are found for the operation of household and light commercial electric appliances and lighting (Wikipedia, 2015,a). These systems are primarily characterized by six parameters: Voltage; Frequency; Grounding; Protection against overcurrent damage (e.g. due to short-circuit), against electric shock and fire hazards; Parameter tolerances; and last but not least their *Plugs and socket-outlets.*

Parameter “Voltage”

Most of Europe, Africa, Asia, Australia, New Zealand and most of South America use a supply voltage that is within 6% of 230 V. In the UK and Australia the nominal supply voltage is 230 V +10%/-6% to accommodate the fact that most supplies are in fact still 240 V. Japan, Taiwan, North America and some parts of northern South America use a voltage between 100 V and 127 V. The 230 V standard has become widespread so that 230 V equipment can be used in most parts of the world with the aid of an adaptor or a change to the equipment’s connection plug for a specific country.

The choice of the *voltage rating of the equipment* (utilization voltage) is due more to historical reasons than the optimization of the distribution system: Once a voltage is in use and equipment using this voltage is widespread, changing voltage is a drastic and expensive measure.

Many areas *such as the USA*, which use (nominally) 120 V, make use of three-wire, single-phase 240 V systems to supply *large appliances*. In this system a 240 V supply has a centre-tapped neutral to give two 120 V supplies which can also supply 240 V to loads connected between the two line wires.

Parameter “Frequency”

The two commonly used frequencies are 50 Hz and 60 Hz. Many other combinations of voltage and utility frequency were formerly used, with frequencies between 25 Hz and 133 Hz, and voltages from 100 V to 250 V.

DC has been almost completely displaced by AC in public power systems. The modern combinations of 230 V/50 Hz and 120 V/60 Hz, which are listed in IEC/TR 60083, *did not apply* in the first few decades of the 20th century and are still not universal.

Parameter “Wiring in buildings”

In many countries, household power is single-phase electric power, with two or three *wired contacts at each socket-outlet.* Neutral and line wire carry current and are defined as *live parts.*

The *line wire* (also known as phase) carries AC between the power grid and the household.

The *neutral wire* completes the electrical circuit – remaining at a voltage in proximity to 0 V – by also carrying AC between the power grid and the household. The neutral is connected to the ground, and therefore has nearly the same electrical potential as the earth.

The *earth wire or ground* connects the chassis of equipment to earth ground as a protection against faults (electric shock), such as if the insulation on a “hot” wire becomes damaged and the bare wire comes into contact with the metal chassis or case of the equipment. Various grounding systems are used to ensure that the ground and neutral wires have the correct voltages, in order to prevent shocks when touching grounded objects.

In northern and central Europe, mixed 230 V/400 V three-phase household wiring is common.

Parameter "Plugs and socket-outlets"

The type of the plugs and socket-outlets is necessarily linked to *the design of the mains power system*. Among all elements of such a system, the plugs and socket-outlets are undoubtedly the *most visible ones*. Unsurprisingly, frustrated travellers who are not aware of the technical implications commonly suggest as panacea the systematic installation of *a single, universal type of plugs and socket-outlets* (Moenius, 2006). This measure, however, would unfortunately represent a typical case of a so-called "Procrustean solution".

Note: In Greek mythology, *Procrustes* was a son of Poseidon who physically attacked people by stretching them or cutting off their legs, so as to force them to fit the size of an iron bed (Wikipedia, 2015,c). In *contemporary usage*, a "Procrustean bed" designates an *arbitrary standard* to which exact conformity is forced. And on the same lines the term "Procrustean solution" refers to the undesirable practice of *tailoring a system to fit a preconceived and inappropriate structure.*

Annex B: Implementations of IEC standard 60906-1

First example: Brazil

Different areas in Brazil traditionally use 60 Hz at different voltages (220 and 120 V), as well as varied types of plugs and socket-outlet systems. As a result, adapters and/or transformers are frequently required for domestic appliances or electronic devices. For example, difficulties are common when a user of such equipment moves within Brazil to a place with a different voltage, or in case of European travelers trying to use their appliances in Brazil (Feller, 2015). To remedy this unsatisfactory situation, IEC standard 60906-1 was adopted by the IEC National Committee of Brazil (COBEI). An *adapted version* was published as Brazil's new national standard for plugs and socket-outlets (using the same design for both voltages; with two pins and a grounding pin). The standard's official designation is "Norma Brasileira (NBR) 14136".

As a result, *new domestic appliances* purchased in Brazil *must* now be equipped with the "universal standard type plug N" (this is a legal requirement). The change of *the socket-outlets,* however, is expected to take a long time: Replacing the *existing mains power system* in a building would obviously be very costly (World Standards, 2015).

Second example: South Africa

The historical background is that he country's unique plug and socket-outlet system stems from the fact that as a former British colony, South Africa adopted the UK standard of three large round pins as early as the 1930s. When the UK switched to flat pins in the 1970s, South Africa should have followed suit, but did not – mainly for commercial reasons.

The present situation is the following: The South African Bureau of Standards (SABS) has identified in 2013 the South African National Standard (SANS) 164-6 as the *preferred standard* for plug and socket-outlet systems. It is based on IEC standard 60906-1, but SABS had to make the necessary adjustments to ensure that SANS 164-2 is compatible with the so-called "Europlug" design (which is required for cell phone chargers). The new configuration is already used *on new installations*. It will be *phased in* over some 20, 30 or even more years (whereas the previous SANS 164-1, of course, has to be *phased out*). It should be noted that *the existing domestic power installations* need not to be adapted for the foreseeable future (Botha, 2015).

One advantage of this course of action is the following: The use of multi-adaptors will eventually be reduced; they are costly and often sub-standard, frequently overloaded and known to have caused fires. Furthermore, most imported appliances are compatible with the *new type* of socket-outlets.

Annex C: Standards as engine for creating wealth

The effects of global standardization are invisible to most people but nevertheless important. If we asked a group of economists to prepare a list on the mechanisms on which the creation of wealth is based, they would *probably not mention standardization* (Swann, 2007). The economists' list may be expected to include more or less the following items: (1) Division of labor; (2) Competition in open markets; (3) Cooperation in utilizing network effects; (4) Innovation; (5) International trade; and (6) Confidence among trading partners.

The point is that the above economic mechanisms will operate efficiently *only if they* are *supported by an adequate global standards system.* Unsurprisingly, most laymen are not aware of this fact.

Abbreviations

AC	Alternating current
CEE	International Commission on Rules for the Approval of Electrical Equipment
COBEI	IEC National Committee of Brazil
DC	Direct current
HBES	Home and Building Electronic Systems
LVDC	Low Voltage Direct Current
SABS	South African Bureau of Standards
SANS	South African National Standard
SC	Subcommittee
TC	Technical Committee
TR	Technical Report

Battle Between Compatibility Standards in a Niche Market: The Case of the Target Archery Equipment Industry

Stijn Verhoeff

Rotterdam School of Management, Erasmus University

pverhoeff@gmail.com

Abstract: *The following paper presents a case study about competing standards in the target archery equipment industry. Specifically, it focuses on the physical interface that connects the two main components of a modern target bow. In the existing literature, theory on competing standards is based on certain industry characteristics and presupposes the existence of conventional market dynamics. Applying this theory to the target archery equipment industry yields unexpected results. The limited number of players and decreased network effects seem to hinder market-based standardisation.*

1 Introduction

In the existing literature, theory on competing standards often uses cases from consumer electronics, such as Blu-ray vs. HD-DVD (Den Uijl, 2015) and VHS vs. Betamax (Katz & Shapiro, 1986), or from ICT (van de Kaa & de Bruijn, 2015). Many of these applications share some common elements. In most cases, the industry in question is large, with many different players. This allows proponents of competing standards to seek the support of other players, in an effort to make it the de-facto standard. The size of the industry allows huge network effects. Furthermore, previous case studies often feature standards that involve some intangible element produced by a different type of stakeholder. Support for the aforementioned case studies was, at least partly, decided by the content providers.

This paper serves as a case study about the target archery equipment industry and aims to test whether the existing theory still applies in industries with different characteristics. In contrast to previous case studies, the target archery equipment industry is – for all intents and purposes – a duopoly. Accuracy and consistency requirements dictate extremely small tolerances, often to fractions of a millimetre. This demands high R&D expenditures for products that sell in a very small market. This makes it hard, and consequently unusual, for the smaller manufacturers to compete in high-end equipment. It also means that players which do possess the required R&D capabilities will produce both of the components that interact with the interface.

2 Research Methods

This paper incorporates the author's ten years of experience in target archery. Given the nature of this niche market and the resulting information asymmetry, this experience is supported by other sources of evidence wherever possible. Illustrations and original patent drawings are included in the Appendices. Annual reports are not available for the industry, making it difficult to accurately estimate market shares and, consequently, to conclude anything about the success of the interface. Measuring its adoption rate among top archers may therefore seem like a viable alternative. However, equipment for top archers is typically sponsored and therefore not the result of the purchasing decisions regular consumers face. For this reason, an analysis is included in Appendix 5, showing the total amount of products on offer for both components interacting with the interface, for both interfaces. These data have been manually coded from ten years of product catalogues, in an attempt to quantify the success of the interface. This provides a reasonably accurate approximation of the relative market share.

3 Case Description

The market for target archery industry is dominated by two companies. Hoyt Archery and WIN&WIN Archery are by far the two biggest players in the industry. Hoyt is part of the Easton sports company, which also owns Easton Archery, possibly the largest producer of high-end carbon arrows. WIN&WIN owns two sub-brands to cater to beginner and intermediate archers, which it uses to rebrand recycled technologies developed for WIN&WIN products.

Appendix 1 shows the modern Recurve bow's anatomy. The main component is the 'riser', a shaped block of aluminium of just over 1kg, commonly sold in 23", 25", or 27" sizes, depending on the archer's height. While cheaper risers are cast into moulds, these may deform slightly during cooling. To ensure that the riser is perfectly straight, high-end risers are machined into complex shapes from solid blocks of aerospace-grade aluminium. A set of two 'limbs' fit into the top and bottom of the riser and flex to shoot the arrows. Options for limbs are plentiful and range from cheaper wood limbs to laminated carbon fibre limbs with carbon foam cores, as well as combinations of wood and carbon. To achieve an efficient power transfer from the limbs to the arrow, the limbs must travel in a straight line. High-end limbs will therefore have lower tolerances for torque and will only flex smoothly in the intended direction. Limbs are typically sold in three sizes, which, combined with the riser, allow for theoretical bow sizes from 64" to 72", at 2" increments. Relatively short limbs will provide a fast, explosive shot, while relatively long limbs will provide a slower, but smoother shot.

3.1 Standards & Regulations

Different modes to achieve standardization described in the literature can be categorized as committee-based, market-based and government-based (Wiegmann, de Vries, & Blind). For most components, the interfaces between them are relatively standardized. Bow strings come in either 16 or 18 strands, which correspond with two standard 'nock' sizes that fit the back of the arrow onto the string. Every component that screws directly into the riser uses a 5/16" thread size; weights that screw into stabilizers uses a 1/4" thread size. These common interfaces emerged over time, often for very practical reasons, without any intervention. This is an illustration of market-based standardization (Wiegmann, de Vries, & Blind).

In fact, World Archery, the international archery league, plays a very passive role in standardization of equipment. Most of its rules are focused on preventing unfair advantages, such as prohibiting the use of electric, electronic, or optical aids. They prescribe only the most basic requirements a bow should meet, as well as the maximum diameter of arrow shafts. Within those limits, archers and manufacturers are free to experiment. It is therefore not uncommon to see customized or home-made components. When the legality of such components becomes questionable, the national archery leagues will call on World Archery to publish a specific interpretation of the rules. Only here do we see that World Archery uses its hierarchical position in this sport to dictate equipment-related decisions. While there is no governmental intervention, World Archery's position is remarkably similar. It is effectively government-based standardization without a government (Wiegmann, de Vries, & Blind).

3.2 Hoyt Dovetail System

The concept of a three-piece bow that could be disassembled was first introduced in 1963 by Bob Lee, an independent bow maker. In the years that followed, each manufacturer that adopted the concept would develop their own proprietary interface. However, assembly and disassembly of the bow were still the only perceived benefits of such an interface. In 1983, Earl Hoyt, of the Hoyt Archery company, filed a patent for an ingenious new interface (Appendix 2). Dubbed the Hoyt Dovetail System, or HDS, it used a lever mechanism to fit the limbs into the riser. As can be seen on the original patent drawing, the limb on the right fits into the riser on the left. A small, spring-loaded, rimmed cylinder (Appendix 2, 50) near the base of the limb slides into a matching slot on the riser (Appendix 2, 60). To ensure vertical alignment, the base of the limb is a U-shaped 'dovetail' (Appendix 2, 35) that fits around the 'tiller bolt' (Appendix 2, 34) on the riser. Thus, by tightening down the tiller bolt, the limb will pivot forward. This feature allows the angle at which the top and bottom limbs fit into the riser to be adjusted individually, which proved essential in tuning bows to suit each individual archer.

The ingenuity of Hoyt's interface was recognized by its competitors and despite the patent, competitors quickly started copying it. Although it is unclear whether competitors found ways to circumvent the patent, or Hoyt choose not to enforce it, Hoyt's interface soon became the de facto standard in the market. To this day, practically all manufacturers which produce risers, limbs, or both, do so using the HDS interface. In fact, many renowned bow manufacturers that continued to use proprietary interfaces, such as Yamaha, are no longer in the market. This large-scale adoption has the huge added benefit for the consumer that risers and limbs from different manufacturers may be used interchangeably. Ironically, its worldwide adoption led someone to coin the term International Limb Fitting (ILF), which stuck with the public. Regardless, Hoyt continues to refer to its interface as 'HDS', as will the rest of this paper.

3.3 Paralever Mounting System

In 2010, Hoyt filed a patent for a new interface called the Paralever Mounting System, accompanied by the launch of the Formula RX riser and Formula Series F4 limbs, which used the new interface (Appendix 3). The main difference with the HDS interface is a longer limb base, increasing the distance between the dovetail and the pivot point. Hoyt argued that the longer base would decrease the extreme lever effect, thus improving vertical limb alignment and decreasing the mechanical stress exerted on the 'limb pocket' which housed the interface. Risers which use the HDS interface require closed limb pockets for structural integrity. Due to the Paralever Mounting System, the Formula RX riser can feature an open limb pocket (Appendix 4), essentially rendering the term 'limb pocket' in itself obsolete.

The patent also covers the introduction of various threaded bushings to screw stabilizers and dampers directly into the limbs. The intended effect is to cancel out any vibrations before they reached the riser. Thus far, the only introduced bushing is located between the dovetail and the pivot point (Appendix 3, 16). In the author's experience, hardly anyone who actually screws dampers into these bushings does so for anything other than aesthetic reasons. In fact, one would be hard-pressed to find archers who use them at all.

3.4 Incompatibility

As limbs using the Paralever Mounting System have a longer base, they are physically incompatible with HDS risers. The other way around, HDS limbs do not fit into Paralever risers. This reintroduces the switching costs previously experienced through proprietary interfaces (Farrell & Klemperer, 2007). The purchasing decision is no longer made within the known product ranges. Rather, consumers must choose whether or not to switch to the different, incompatible interface, prior to considering other factors.

According to Katz & Shapiro (1994), the two possible outcomes to compatibility problems for systems are standardizing or adapting. Standardization results in lower product variety, while adapting results in decreased performance. The relatively unknown French manufacturer Uukha produces an adapter to fit their proprietary HDS limbs into a Paralever riser. Taking a different approach, MK Korea launched their Alpha riser in 2015, which can accommodate both HDS and Paralever limbs. However, these adapters are very uncommon and achieve compatibility at the expense of an already limited performance improvement.

Matutes & Regibeau (1988) view a system not as a single product, but instead as the sum of two or more components. They apply game theory to a hypothetical duopoly, in which each player sells a two-component system; this resembles the archery equipment industry much more closely. They found that if adapting is not feasible, such a scenario would tend towards either standardization or incompatibility. Given these options, only sufficiently differentiated standards will outweigh the benefits of interchangeability enough to allow for their coexistence (Katz & Shapiro, 1994).

4 Case Analysis

4.1 Cross-side Network Effects

As the riser and limbs have no value in isolation, consumers must purchase an entire bow when switching and are henceforth locked into purchasing future upgrades with the same interface. However, upgrading risers and limbs is not typically done in rapid succession, for two main reasons. Firstly, it takes time to retune the bow and adjust to the different feeling. Young archers are the exception here, as their rapid growth in both height and strength necessitates more frequent upgrades. Secondly, as high end risers and limbs can cost as much as €500 -800, their interchangeability allows consumers to spread upgrades over time. Switching to the Paralever system would require an upfront investment of around €1500. Purchasing decisions regarding the interface will therefore include the availability of upgrades several years down the line. As it is unclear whether the Paralever interface will be successful enough to stay viable, this includes the possibility that the Paralever interface could be discontinued. In that eventuality, switching back would require a similar investment. These transactional switching costs leaves many consumers hesitant to switch (Farrell & Klemperer, 2007).

This yields an interesting application of cross-side network effects. As consumers are unsure whether the supply side will still be around after a few years, they are more reluctant to switch. This effectively results in low demand, which in turn will only make future supply less likely. We can see here that assumption-based reciprocal cross-side network effects leave the industry in a stalemate. Literature on two-sided markets suggests that to attract more demand, the side that must deliver the quality must be charged (Eisenmann, Parker, & Van Alstyne, 2006), while the consumers must be subsidized. Katz & Shapiro (1986) confirm that adoption of new technologies in the presence of network externalities depends on whether the technologies are sponsored. Techatassanasoontorn & Suo (2011) argue that while high switching costs in static markets are more likely to lead to coexistence than tipping, dynamic pricing strategies can help increase adoption.

4.2 Dominant Design

The original HDS interface became the de-facto standard because it was superior to all other solutions at the time and provided additional functionality. However, when we look at the introduction of the Paralever interface, it is clear that compatibility and existing network effects play a role too. In Den Uijl's (2015) attempts to harmonize the concepts of dominant design, compatibility and platforms, he argues that the term de-facto standard refers to the overlap of these concepts. Indeed, taking any single perspective on the Paralever interface would not provide the complete picture. One could argue that the success of the HDS standard – and the compatibility and network effects it introduced into the market – made competition on interfaces infinitely more complex.

As previously mentioned, the static nature of the market combined with high switching costs would theoretically allow for the coexistence of multiple standards. Realistically though, coexistence is unlikely. Given the small market size and high development costs, splitting the market between two interfaces would decrease economies of scale for both, resulting in a sub-optimal situation (Farrell & Klemperer, 2007). Hoyt would have to divide its attention to simultaneously sustain the Paralever interface and compete on the HDS interface. Granted, some engineering results may be applied across both interfaces. In fact, Hoyt's GPX riser, launched in 2014, is an HDS riser that borrows its geometry from the Paralever Ion-X riser. However, these minor benefits are unlikely to merit the R&D expenditures associated with two separate product ranges.

4.3 Competition versus Coopetition

In order for the Paralever interface to become the new de facto standard, it would have to be adopted by other manufacturers. In this respect, Hoyt's decision to patent the interface no longer seems very sensible. The HDS interface was patented, but became the de facto standard anyway by being sufficiently superior to any other available interface to incentivize competitors to adopt it by circumventing or ignoring the patent. Hoyt seems to be repeating itself with the Paralever interface, with the notable exception that this new interface is not perceived to be sufficiently superior. However, there is another dimension to this issue that applies to the competitive nature of the industry. Supposing another manufacturer would adopt the Paralever interface, it would always want to produce both risers and limbs. Otherwise, the interchangeability it would introduce within the Paralever interface would also provide Hoyt with additional sales. Logically, any direct competitor of Hoyt will thus either invest in an entire new product range or forego the opportunity altogether (Farrell & Klemperer, 2007).

Had Hoyt anticipated this reaction, they could have instead decided to open up the intellectual property rights. By actively stimulating other manufacturers to adopt the Paralever interface, they could have gained much needed traction in the market, meanwhile signalling greater odds of success to the consumer. Farrell & Klemperer (2007) suggest that switching costs can be reduced by either licensing to competitors or by creating a differentiated sub-brand. Hoyt attempted the latter by introducing their entry level 'Excel' riser and limbs in the Paralever interface. However, by initially marketing the Paralever interface as a ground-breaking new interface, the contrast could not have been greater. Rather than adapting inferior components to promote a supposedly superior interface, Hoyt may have been better off licensing the interface to other manufacturers. As can be seen in Appendix 5, Hoyt's product range has doubled in size since the introduction of the Paralever interface. However, WIN&WIN's decision not to adopt it clearly limits its appeal.

5 Conclusions

The introduction of the Paralever interface promised superior performance, at the expense of interchangeability. However, questionable performance improvement claims were not enough to convince other manufacturers to adopt the standard. The resulting doubts about future availability of supply, combined with high switching costs, made consumers hesitant to embrace the new interface too. Opportunities to cooperate with other manufacturers to signal greater confidence in the interface were neglected, in favour of using inferior in-house products to promote a supposedly superior interface. Attempts to stimulate demand directly at the consumer side were similarly foregone by following the conventional logic of high initial pricing to recuperate development costs. It seems as though Hoyt tried to singlehandedly change an industry standard – which they themselves had created – with utter disregard for the rest of the industry. Despite all their R&D efforts to develop the Paralever interface, they have foregone opportunities to gain or maintain momentum at every turn. Meanwhile, they cannot afford to give up on their HDS customer base by leveraging its inferiority in support of the Paralever interface. Consequently, they now find themselves in a stalemate.

When applying the literature step by step, we can conclude that this outcome is not unforeseeable; Hoyt merely attempted to protect its own short-term interests by keeping the competition at a distance. In doing so, however, they inadvertently doomed their own innovation. As counterintuitive as it may seem, the only way to ensure the viability of the Paralever interface would be to share it with the competition. Throughout this case study, we can see that the industry characteristics have a major impact on the outcome of this standards battle. Previous case studies have looked at large, potentially profitable industries with many different players. In the target archery equipment industry, the relatively high development costs and a small market seem to result in a natural limit to the number of players in the market. Furthermore, as the same players produce both of the components that interact with the interface, there is no option to gain support from other types of stakeholders. It seems the nature of this particular industry constrains the conventional dynamics of standards battles to the point where a practical application of the theory will not result in the expected outcome.

Existing theory on competing standards presupposes the existence of conventional market dynamics required in market-based standardisation. When applying van de Kaa et al.'s (2011) framework for interface format battles, there are several factors that are consistent with the failure of the Paralever interface. Foremost, the interface lacked the 'Technological superiority' that seems to be indicative – but not decisive – of the likelihood of its success. Market factors such as 'Switching costs' and 'Uncertainty in the market' are also consistent with the observed consumer behaviour. However, the framework fails to explain how the number of players in the industry – as well as the nature of these players – can influence the likelihood of success of the interface. Furthermore, it fails to account for the influence of development costs. Ultimately, van de Kaa et al.'s (2011) framework clearly illustrates that while theoretical studies are abundant, there is very little empirical support. This case study attempts to add to the existing literature by showing that the absence of conventional market dynamics – in particular decreased network effects – may hinder market-based standardisation. In such conditions, 'government-based' standardisation might be more appropriate. Intervention by some governing body might prevent players in small industries from engaging in standards battles that cannot be won and wasting valuable R&D efforts in the process. In this case, this governing body could have been the sports association, World Archery. Future research might therefore shed more light on how industry characteristics affect the application of existing theory.

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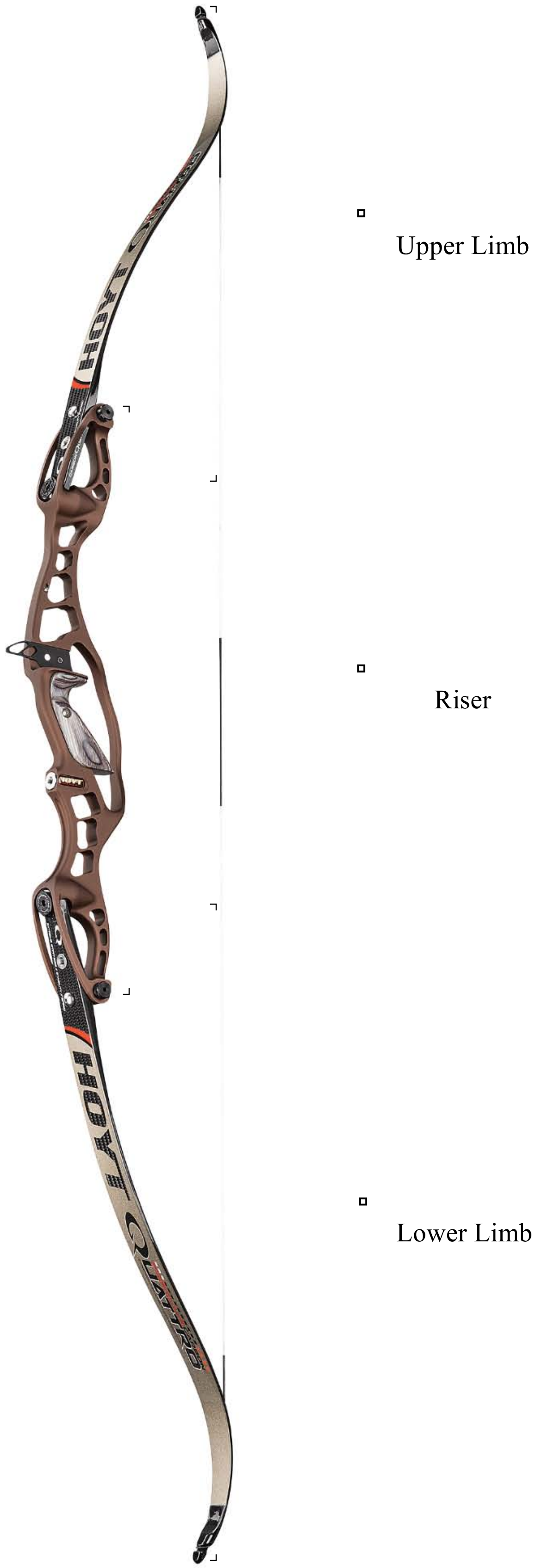
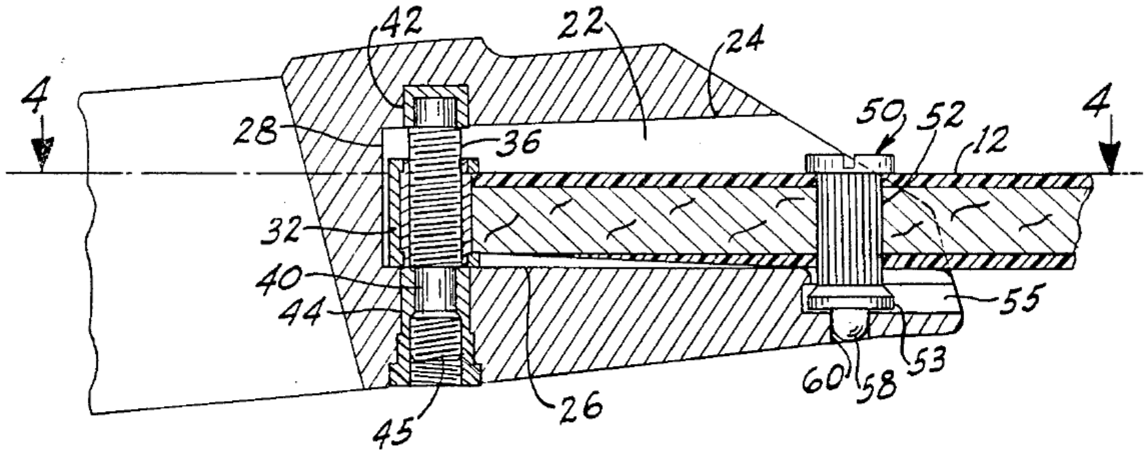
Appendices

Appendix 1. Modern Recurve bow (Hoyt Prodigy XT riser & Hoyt Formula Series Quattro limbs)

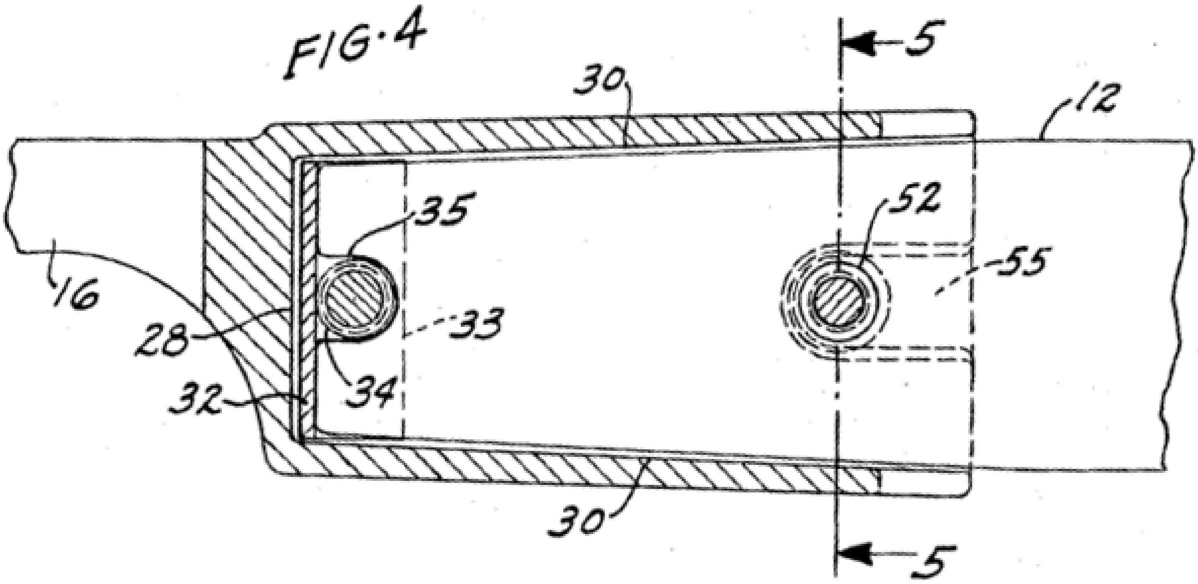


Appendix 2. Hoyt Dovetail System, Patent No.: US 4,494,521

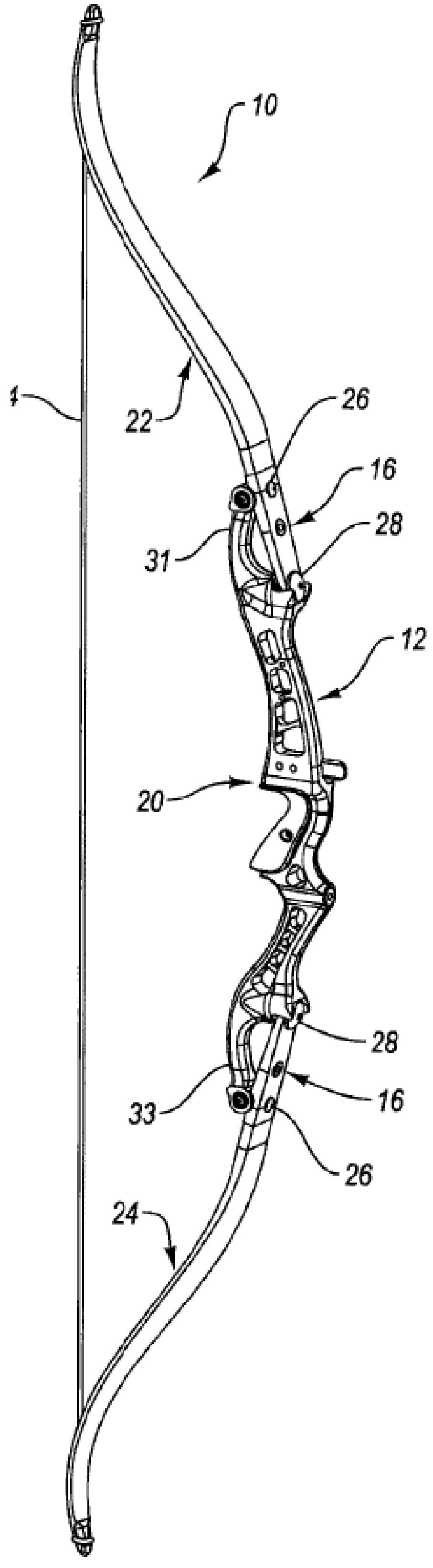
Side-view cross-section

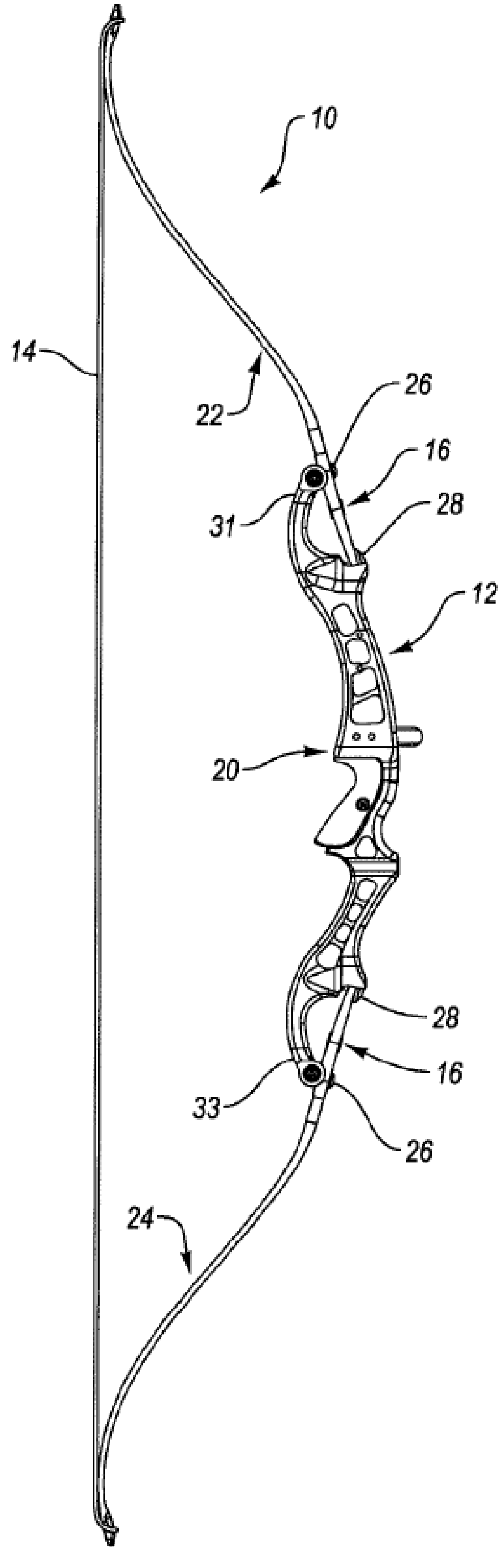


Top-view



Appendix 3. Paralever Mounting System, Patent No.: US 8,365,712 B2





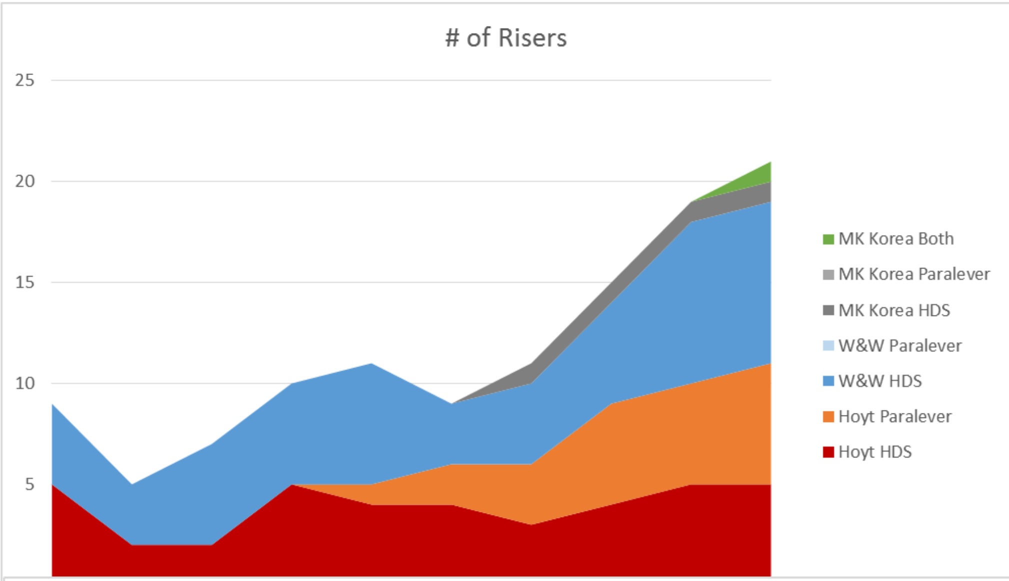
Appendix 4. 2009 Hoyt GMX (HDS) versus 2011 Hoyt Formula RX (Paralever)

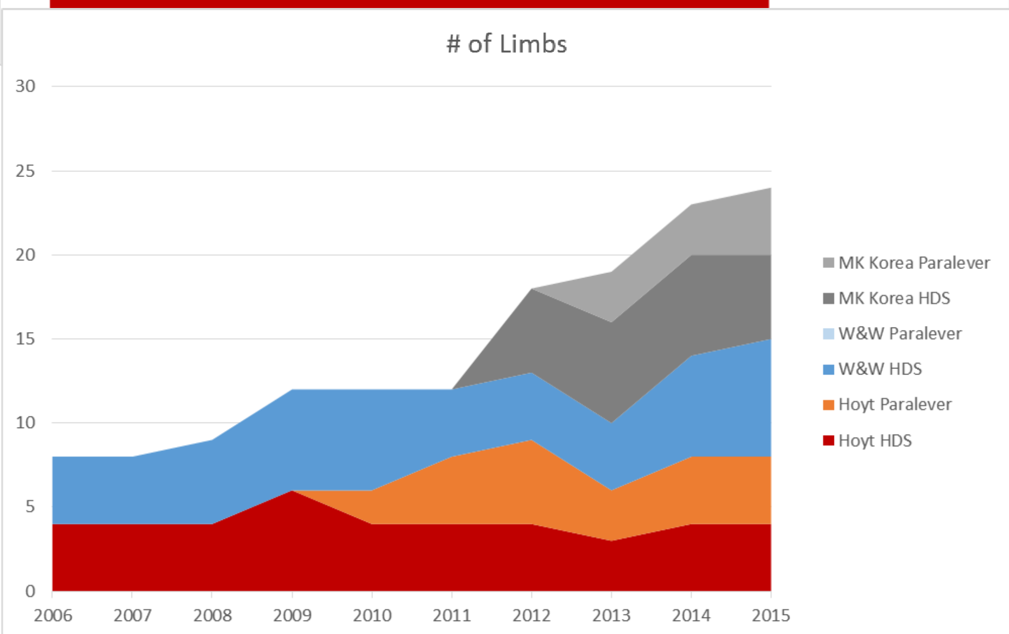
Appendix 5. Product variety of HDS and Paralever risers and limbs

The following charts display the total amount of risers and limbs on offer each year for the HDS and Paralever interfaces. As annual reports are not available for the industry, data has been manually coded from ten years of product catalogues.

Note 1: For MK Korea, the 2013 product catalogue was unobtainable; values have been interpolated where possible and the remaining product introductions have been deduced from product reviews on various forums.

Note 2: Although the small Scottish manufacturer Border produces Paralever limbs, it has been omitted from the analysis. These limbs are custom-made for each archer and are not even listed on their website.





Standardization and Coopetition: A Study of Pharmaceutical Industry Consortia[1]

Joel West

Keck Graduate Institute
KGI@joelwest.org

Abstract: *This study examines coopetition in multi-firm consortia organized in the pharmaceutical industry. From a sample of 87 consortia related to biomedical research, it identifies 34 that are substantially or entirely involved in standardization activities. From these 34, it offers a taxonomic classification into six categories of standardization efforts: Information and Communications Technology standards, open source ICT implementations, standardized inputs, data standards (and standardized data), process standards and quality standards. From this, it examines the cooperative and competitive aspects of these standardization efforts and the role they play in firm advantage, contrasting them to the better-known examples of ICT standardization.*

1 Introduction

Voluntary cooperative standardization creates a shared good that both benefits the broader society and the private interests of those involved in standardization (Kindleberger, 1983; Leiponen, 2008). By combining both cooperative and competing motives, the creation and use of shared standards corresponds to Brandenberger and Nalebuff's (1996) definition of coopetition (Gnyawali & Park, 2011). Today, many industrywide product compatibility standards are created through the formation of a consortium of multiple firms, a special-purpose organization supported by member fees and governed by mutually agreed-upon rules (Weiss & Cargill, 1992; Blind & Gauch, 2008). Such multilateral cooperation also represents an important form of open innovation, in that firms share knowledge to create value while combining shared and private knowledge to capture value (Simcoe, 2006; West 2014a).

Open collaboration through standardization consortia is most often associated with the Information and Communications Technology (ICT) industries (David & Steinmueller, 1994; Blind & Gauch, 2008). Examples include mobile telecommunications (Bekkers et al, 2002), smartphones (West & Wood, 2013), the Internet (Waguespack & Fleming, 2009) and open source software (West, 2003). Such consortia create standards that are usually public goods (Kindleberger, 1983; Weiss & Cargill, 1992) and are non-rivalrous in consumption (Liebowitz and Margolis, 1992). Created through voluntary collective action (Simcoe, 2012), these consortia and their standards create an alternate form of non-market governance (Hallström, 2004). Such cooperative standardization fits the definition of coopetition, in that cooperation by competing firms (Leiponen, 2008) create standards that can create new markets or even industries (e.g., Keil, 2002). Such standardization activities may be more or less open, to the degree that they allow participation by a wide range of stakeholders, including customers, complementors, and direct competitors (West, 2007).

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However, one industry not typically known for such cooperation has been the pharmaceutical industry. In this industry, multinational firms spend more than $100 million in R&D costs to bring a single new compound to market on the basis of a patent on that compound (Grabowski, 2002; DiMasi et al, 2003; Pisano, 2006). Their willingness to make risky investments in R&D and other costs of bringing a new technology to market (and their business models more generally) thus depends on the certainty of strong appropriability provided by the patent's temporary monopoly on that technology (cf. Arrow, 1962; Teece, 1986; Cohen et al, 2000). These firms have also enjoyed high margins and large cash flow that allowed them to pursue go-it-alone strategies, building vertically integrated firms that include their own R&D, manufacturing, sales and distribution (Temin, 1979).

Such vertical integration and high dependence on patent-based business models meant that open collaboration was uncharacteristic of pharmaceutical firms, until they began to form and join their own R&D consortia in the late 1990s (West & Olk, 2016). The shift towards openness came as the leading pharmaceutical firms faced a decade of increasing R&D costs and failure rates for R&D, bringing decreasing returns to R&D and declining profit margins (Munos, 2009; Scannell et al, 2012). In response, pharmaceutical companies have begun to cooperate through dozens of consortia that share the cost of R&D and other responsibilities.

While these efforts are patterned on Sematech and other traditional industrial R&D consortia of the 1980s and 1990s (cf. Evan & Olk, 1990; Mowery, Oxley & Silverman, 1996), there appear to be crucial differences. Compared to the earlier consortia, these pharma consortia are more open in that the knowledge created spills over to the entire industry and society at large, meaning that there are weaker incentives for firms to provide financial support for these consortia (West & Gallagher, 2006; West & Olk, 2016).

Some of these pharmaceutical consortia are involved in creating cooperative industry standards. This study offers the first comparison of such standardization efforts in the pharmaceutical industry. Here I identify 34 consortia that fit into six categories: ICT standards, open source ICT implementations, other standardized inputs, data standards, process standards, and quality standards.

Using this data, the remainder of this paper offers preliminary observations as to how such standardization differs from the oft-studied examples in the ICT industry, particularly in terms of the nature of the public good and the role that the standard plays in the firm's business model. It concludes with suggestions for future research.

2 Theoretical Background

Research has identified that an important form of multi-lateral firm cooperation is the R&D consortium, particularly after 1984 legislation in the United States that relaxed antitrust restrictions for certain forms of cooperation (Ring, Doz & Olk, 2000). Such consortial collaboration corresponds to a particular form of network collaboration within open innovation, in that member firms in a consortium generate, share and receive knowledge flows across a network of collaborations (West, 2014a, 2014b). Numerous examples of such collaborations can be found in the standardization consortia used to generate voluntary industrywide standards (Simcoe, 2012; Xia et al, 2012).

A crucial tension in the operation of such consortia is managing the conflict expectations of the participating firms, between the shared interest of the members in creating value, and the private interests of members in capturing value (Simcoe, 2006). This corresponds to what Brandenburger & Nalebuff (1996) term as "coopetition," in which a group of two or more firms both cooperate and compete in the same market or industry. Creating, evolving, supporting and implementing compatibility standards provides an important example of such coopetition, in that the cooperation of participating firms creates value through their shared standard, while the firms continue to compete to capture value through their respective products (Simcoe, 2006; Gnyawali & Park, 2011).

2.1 R&D Consortia

R&D consortia are an inter-organizational form to allow coordination between firms and other organizations. These consortia pool the financial and other resources the member organizations to achieve a shared organizational purpose, while at the same time allowing these organizations to achieve their private interests. Cooperation is made more difficult by the heterogeneity of member firms, their goals and approaches towards achieving those goals both inside and outside the consortium (Olk, 1999; 2002; Ring et al, 2005).

These consortia are created to develop new product or process standards, new technology, or to address changing regulatory requirements upon the industry. One example of the latter is the International Pharmaceutical Aerosol Consortium, the first known example of a multi-firm consortium in the pharmaceutical industry that was formed in 1987 to develop a new aerosol for asthma inhalers after the previous formulation was banned by international treaties (IPAC, 1999).

However, the pharmaceutical consortia studied here add a third level beyond the firm and the consortium: spillover benefits to non-members. Firms, organizations, competitors and other entities not part of the collaboration may achieve clear benefits from the efforts of the consortium: the collaboration between member companies thus functions as an open system (Chesbrough, 2006; West & Gallagher, 2006). For a variety of reasons discussed later, most (thought not all) pharma consortia encourage such spillovers and the dissemination of this knowledge as a public good. These spillovers create potential conflicts between the shared goals of the consortia (and broader public) and the private interests of the member firms providing the resources to support the consortia (West, 2007).

2.2 Open Innovation, Standardization and Coopetition

A special form of consortium is one that produces interfirm standards. Such standards can be classified into two categories: compatibility and quality (Hemenway, 1975). The first form assure compatibility between products from varying sources (West, 2007), allowing for interoperability and modularity in the division of labor within an industry (Baldwin & Clark, 2000; Keil, 2002). The second form reduce coordination costs by providing a common definition of product (or process) quality for firms within an industry (Hallström, 2004).

Open innovation is by definition how firms allow intentional knowledge inflows and outflows to advance their innovation strategies. In open innovation, such knowledge flows must be aligned to the firm's business model, and in particular its ability to create value for customers and capture value to support its private financial interests. (Chesbrough, 2006). While research on open innovation has emphasized bilateral alliances between two firms, an important form of open innovation strategy is through network cooperation (West, 2014b). Standardization is thus an important example of open innovation (Simcoe, 2006).

These network forms include most forms of standards cooperation, including platform ecosystems and standardization consortia (West, 2014a). Such consortia often include direct competitors (Weiss & Cargill, 1992; Leiponen, 2008). In some cases, these consortial collaborations benefit the member companies preferentially to other firms (Keil, 2002). But in other cases, such as open source software consortia, the benefits of the consortia spillover to non-members (West & Gallagher, 2006).

Open innovation is particularly evident in telecommunications standardization, where all firms face a common need for anticipatory standardization, because interoperability is an inherent requirement for such communications products (David and Steinmueller, 1994). Participating firms cooperate both to define a standard that each firm will implement and win adoption of the standard by a wide range of stakeholders, which may include hardware makers, software developers, telecommunications network operators, dealers, and end customers (Dittrich & Duysters, 2007; West & Wood 2013).

Such cooperation by directly competing firms (Leiponen, 2008) fits the definition of coopetition (Brandenburger & Nalebuff, 1996), in that competing firms gain through cooperation in producing a shared good. This shared good comprises an external innovation that provides an input to the open innovation strategies of the firms (West, 2014a). At the same time, cooperative standardization among direct competitors exposes the multiple tensions inherent in coopetition. Both individually — and as a group — the members face a tension between maximizing both the value created through cooperation and the private value they capture as competitors (Simcoe, 2006). The process of cooperation slows down as the competitive stakes increase, as Simcoe (2012) demonstrated using data from the Internet Engineering Task Force.

A seemingly intractable problem comes when strong intellectual property rights (i.e. patents) are an integral part of a firm's business model. The presence of such IPR increase the private value captured by one or more member companies while increasing the costs (and decreasing the value capture) of other standards users; for example, the W-CDMA mobile telecommunication standards were written to overlap lower-quality IPR of key member companies (Bekkers & West, 2009). The proliferation of (often unsuccessful) consortia policies to constrain such opportunism (Ring et al, 2000) is a testament to the difficulty of balancing cooperation and competition when the potential value capture is large.

Thus we expect tensions of coopetition for any industry standardization when the cooperation involves large multinational firms and a heavy reliance on intellectual property. Such a description describes well the industry dynamics of the pharmaceutical industry.

3 Context: Private and Cooperative Pharmaceutical R&D

3.1 Big Pharma's Traditional R&D Model

The traditional pharmaceutical R&D model is based on vertically integrated drug discovery and development over a decade or more. Starting from the discovery of a candidate drug, it takes an average of 12 years and $150-200 million to bring a new drug to market, with most of the time and cost associated with running human clinical trials. However, those estimates need to be increased sixfold to cover the costs of those drugs that fail prior to regulatory approval (DiMasi et al, 2003; DiMasi & Grabowski, 2007; Pammolli et al, 2011).

Given these factors, it is not surprising that the industry is highly dependent on patents (Cohen et al, 2000; Grabowski, 2002). It also has a very high R&D intensity. The world's 50 largest pharma companies achieved combined sales of more than $600 billion in pharmaceutical revenues in 2014, and spent more than $100 billion of that on pharmaceutical R&D (Swanick et al, 2015). Of these, the top 20 accounted for $482 billion in revenues and nearly $82 billion in R&D, with $48 billion of that R&D performed by U.S.-based firms and $43 billion by European firms (see Table 1).

Table 1: Leading Global Pharmaceutical Companies in 2014

Rank	Company	Country	Drug Sales	Pharma R&D Spending	R&D intensity
1	**Novartis**	Switz.	$46.13 B	$9.30 B	20.2%
2	**Pfizer**	U.S.	$44.51 B	$7.15 B	16.1%
3	**Roche**	Switz.	$40.09 B	$8.61 B	21.5%
4	**Sanofi**	France	$38.22 B	$6.20 B	16.2%
5	**Merck & Co.**	U.S.	$36.61 B	$6.53 B	17.8%
6	**Johnson & Johnson**	U.S.	$30.73 B	$6.03 B	19.6%
7	**GlaxoSmithKline**	U.K.	$30.30 B	$4.87 B	16.1%
8	**AstraZeneca**	U.K.	$25.69 B	$4.94 B	19.2%
9	Gilead Sciences†	U.S.	$24.47 B	$2.74 B	11.2%
10	**AbbVie**	U.S.	$19.88 B	$3.25 B	16.4%
11	Amgen†	U.S.	$19.33 B	$4.12 B	21.3%
12	Teva††	Israel	$17.47 B	$1.49 B	8.5%
13	**Bayer**	Germany	$16.35 B	$2.50 B	15.3%
14	**Eli Lilly**	U.S.	$16.35 B	$4.38 B	26.8%
15	**Novo Nordisk**	Denmark	$15.83 B	$2.45 B	15.5%
16	**Boehringer Ingelheim**	Germany	$13.90 B	$3.15 B	22.7%
17	**Takeda**	Japan	$13.04 B	$3.18 B	24.4%
18	**Bristol-Myers Squibb**	U.S.	$11.97 B	$3.91 B	32.7%
19	Actavis††	Switz.	$11.13 B	$1.09 B	9.8%
20	**Astellas Pharma**	Japan	$10.42 B	$1.86 B	17.8%

Source: Swanick et al (2015). **Bold** indicates incumbent “big pharma” firm
† Dedicated Biotech Firm †† Manufacturer of off-patent drugs

More recently, the large incumbent pharmaceutical companies have faced two major challenges. The first has been the emergence of dedicated biotechnology firms (DBFs) that entered the market since the 1980s, using a new scientific paradigm that devalued big pharma’s traditional chemistry-based competencies; to access these new competencies, incumbent pharma firms partnered with or acquired the DBFs (Galambos and Sturchio, 1998; Pisano, 2006). The second factor has been declining R&D productivity — particularly for the largest firms — due to high R&D spending and fewer approved drugs (Munos, 2009; Paul et al, 2010; Pammolli et al, 2011). One major reason has been the “Better than the Beatles” challenge (Scannell et al (2012): new drugs must compete with former blockbuster drugs that (after expiration of their patents) are available as lower-cost generic pharmaceuticals. In fact, the older DBFs are larger, vertically integrated, and face many of the same R&D challenges (DiMasi & Grabowski, 2007). Thus both big pharma and larger DBFs are seeking new approaches to improve the effectiveness or reduce the costs of R&D.

3.2 Open Innovation and Open R&D Consortia

In response to these pressures, pharmaceutical companies have embraced open innovation to harness external sources of knowledge to accelerate internal R&D and increase the efficiency and effectiveness of their innovation efforts (Hunter and Stephens, 2010; Bianchi et al, 2011; Salah and McCulloch, 2011). One form of such open innovation has been bilateral cooperation with universities (Melese et al, 2009; Ratner, 2011).

Another approach (adopted by some but not all firms) has brought an unprecedented level of collaboration between previously proprietary rivals, often in conjunction with government, university or other nonprofit entities. This has led to the creation of consortia that pool existing firm knowledge, engage in pre-competitive R&D, define standards and roadmaps for key enabling technologies, and engage in post-approval activities such as monitoring the safety of released products. Such collaborations are the subject of the proposed study.

In this regard, the range of organizational forms more closely resembles corporate funded open source software (cf. West & O'Mahony, 2008) than R&D consortia organized under the National Cooperative Research Act of 1984 or the National Cooperative Research and Production Act of 1993 (cf. Olk & Young, 1997). However, it is difficult to generalize the characteristics of these consortia without a comparative study of multiple consortia and their member interactions (comparable to the aforementioned studies of open source software and R&D consortia). Such a comparison is one of the goals of this study.

3.3 Research Design

This paper is part of a larger multi-year project studying consortia in the global pharmaceutical industry. The project is compiling a variety of data on each consortium, including history, mission, purposes, activities, governance, and corporate and nonprofit sponsoring organizations. The data have included information from the current company website, previous versions of the website (from Archive.org), published articles in scientific journals and industry magazines, supplemented by a small number of interviews with consortia participants (which are still in progress).

To develop our list of consortia, scholarly and press articles were searched to identify R&D consortia, as well as related forms of inter-organizational cooperation related to pharmaceutical development. Our initial search for consortia identified 87 consortia. Half included "consortium" in their title, and most appeared headquartered in the US or Europe. Two of the earliest and most influential consortia appear to be the NIH-organized Biomarkers Consortium and the international Structural Genomics Consortium (which was studied by Perkmann & Schildt, 2015). From the 87, using secondary data I identified 34 as being entirely or primarily related to one or more approaches to standardization.

4 Standardization in Pharmaceutical Consortia

The 34 standardization-related consortia can be subdivided into six categories: ICT standards, open source ICT implementations, standardized inputs, data standards (and standardized data), process standards, and quality standards (Table 2).

4.1 ICT Standards

The most recognizable example of standardization among the pharmaceutical consortia are those consortia that develop ICT compatibility standards. As biomedical research has become increasingly automated — and increasingly dependent on large databases related to therapeutic compounds, genetic data and other aspects of human health, pharmaceutical companies have chosen to become more directly involved in industry-specific ICT standardization (cf. Markus et al, 2006).

However, the organization and control of these efforts represent a subset of the full range of structures and openness that have been reported in ICT standardization (cf. West, 2007). All are performing industry-controlled multi-firm standardization similar to industry-sponsored standards setting organizations (e.g. Keil, 2002). At one extreme, they exclude the government-developed (US Department of Defense, 1983) or government sanctioned (Bekkers et al, 2002) open standardization efforts. At the other extreme, they exclude the single-firm proprietary standards that were common for many years in computing (Langlois, 1992; Bresnahan & Greenstein, 1999), or the firm-dominated open communities more recently used in open source software development (West & Lakhani, 2008).

Table 2: Classification of Standardization-related Pharmaceutical Consortia

Category	Goal	Com-patibility	Qual-ity	Imple-mentation	Num-ber	Examples
ICT Standards	ICT standards	X			5	Allotrope, BioMedBridges
Open Source ICT Implementations	ICT system	X		X	3	TransCelerate, tranSMART
Other Standardized Inputs	Make inputs to firm products	X		X	3	Infectious Disease Research Institute
Data Standards and Standardized Data	Representation of biomedical research or clinical data	X	X	*some*	15	Biomarkers Consortium, ICGC, International Serious Adverse Event Consortium
Process Standards	Processes for pharmaceutical research, production or use		X	*some*	6	Predictive Safety Testing Consortium, Rx-360, TransCelerate
Other Quality Standards	Standards for product or process quality		X		3	International Pharmaceutical Privacy Consortium, IQ Consortium
Totals					34†	

† One consortium covers two categories

Perhaps the clearest example is the Allotrope Foundation, founded in 2012 as a spinoff of the IQ Consortium. The goal of Allotrope is to develop and win adoption of standards for analytical instruments, so that biomedical researchers (both in academia and industry) can mix and match data collection from various vendors and easily import that data into their research databases. The consortium includes both participation by pharma companies (that are among the customers for these instruments) and the vendors that make these instruments.

4.2 Open Source ICT Implementations

Open source software (OSS) forms a special case of standards openness. Under standard open source licenses, the technology and architecture are fully open to standardization participants and non-participants alike (West & O'Mahony, 2008). While standardization efforts have often provided for prototype implementations to test for standards completeness (Russell, 2006) or interoperability between vendors (Manninen, 2002), participating firms historically competed on implementations (Garud et al, 2003). However, unlike a typical open standard, an OSS project can both define a standard and also provide a shared implementation freely available to any firm — thus enabling entry by small firms that do not have the resources to develop their own implementations (West, 2003). An example of this can be seen with the adoption of Linux, an open source offshoot of Unix that — because it was freely available — displaced the established Unix standard at the end of the 20th century.

Like other 21st century IT professionals, the IT professionals of the pharma industry are both aware of the successes of open source software and aware of its potential impact on their work (e.g. Ince et al, 2012). Pharma companies have only recently begun to recognize that many previously proprietary activities do not generate competitive advantage — leading to the rise of many of these pharmaceutical consortia (West & Olk, 2016). Thus, it is not surprising that some pharma firms and their IT managers would choose to embrace creating consortia that both create ICT standards and create a common implementation that can become shared infrastructure for the entire industry.

One example of a pharma OSS project is TransCelerate Biopharma, founded in 2012. The consortium engages in a range of standardization efforts, including process standards (discussed below). However, one of its major initiatives is the Shared Investigator Platform, an online system for managing clinical trials. Biomedical products for human health require lengthy (and usually extensive) clinical trials to demonstrate safety and efficacy. Such trials are typically conducted by dozens of local research hospitals under contract to pharma companies, with hospitals often working on multiple trials (with multiple companies) simultaneously. Much as an open Internet email architecture of the commercial Internet supplanted the need to maintain e-mail accounts in multiple proprietary e-mail systems (cf. Greenstein, 2015), TransCelerate sponsors hope that clinical trial sites and sponsoring firms can communicate results using a single IT infrastructure.

4.3 Other Standardized Inputs

Standardization has important benefits of providing inputs for the design of complex modular products (Hemenway, 1975; Ulrich, 1995). For many standardized technologies — particularly low-technology components such as screw threads or connectors — the specific of the standard enables entry by multiple competing suppliers.

However, in the heavily regulated biomedical sector, the cost of regulatory compliance may discourage the provision of inputs. In other cases, proprietary intellectual property (typically patents) will provide a temporary monopoly in the provision of these inputs.Two related consortia — BioBricks and iGEM — are organized to encourage the donation of synthetic biology building blocks that are made available via open source. Both are explicitly modeled on the ideas of modularity and sharing for open source software, but thus far have had more of an impact on teaching than on pharmaceutical development.

A third consortium, the Infectious Diseases Research Institute, is working to accelerate the development of diagnostics, therapeutics, and vaccines funded by a range of public (European Commission; US Army, DoD, National Institutes of Health), foundation (Allen, Gates, Wellcome), and industry (Eli Lilly, Novartis, Sanofi). It is developing molecules that can be used for diagnostics and adjuvants that enhance the performance of vaccines.

4.4 Standardized Data

The sequencing of the human genome — and the rapid decline in the cost of sequencing the genome of individual patients — has brought a deluge of genomic data and predictions of a revolution in biomedical research (Collins, 2010). However, the usefulness of compiling and sharing this data — between biomedical firms, health providers, academic researchers, and others — requires standardizing both the syntax and the semantics of the representation of this data. Many of the issues reporting genomic (and transcriptomic, proteomic, and other "-omic") data did not exist before this genomic revolution. Representing and sharing this data thus requires standardizing the content, annotation, syntax, and semantics of data relevant to the specific biomedical problem being solved (Field & Sansone, 2006).

Given the exponential growth in the supply of genomic data, the new content being represented, and the increasing emphasis of academic and industry scientists in utilizing such data, it is thus not surprising that many consortia have been formed to compile such biomedical data, define standards for storing the data and creating online databases for publicly disseminating this data. In fact, this is by far the most popular of the categories in our sample, accounting for almost half of the consortia involved in standardization.

These consortia define a standard format for representing such data in electronic form. In many cases, this standardization is merely a first step for gathering such data – create data, collect, curate, and combine data into a single shared database (i.e. public good) available to all. The process of scientific research is highly dependent on such standardized knowledge platforms that serves as inputs to the scientific enterprise (Fehder et al, 2014).

In the 21st century, this data provides a common infrastructure of scientific knowledge to support genomic-based biomedical research — both basic research by academic scientists and product-oriented applied research by industry scientists. Given the application to basic research — and the public good nature of this information — many of these projects are funded through public/private partnerships or (in some cases) entirely by government and/or foundation support.

In the U.S., the largest and best known of such consortia is the Biomarkers Consortium, established in 2006 as a public-private sponsorship between the U.S. National Institutes of Health and leading drug companies. The goal of the consortium is to sponsor (usually university) studies to identify and validate biomarkers, which are sought as efficient and inexpensive genetic or cellular (e.g. blood test) proxies for more complex medical states (such as organ failure or the successful treatment of cancer).

A data effort with a more direct impact on discovering new drugs is the International Cancer Genome Consortium (ICGC). This international collaboration is gathering genomic and other data on more than 25,000 tumors across a wide range of cancers. It is funded by national cancer agencies from the EU and more than 10 countries, plus a small number of foundations (such as the Wellcome Trust) and research institutes. However, those data are primarily being used by university, clinical and nonprofit researchers. The consortium lists 223 projects where researchers received access to confidential data (ICGC); of these, only 10% (22) of the projects involved corporations, including two projects from major pharma companies (AstraZeneca, Roche) and two from publicly traded DBFs (Cellgene, Regeneron).

4.5 Process Standards

Because of the potential impact of biomedical products on human health, the process for research, production and distribution must meet specific quality standards to win regulatory approval (Yu, 2008). While — depending on the regulator and context — industry may have little or no impact on the formal standards, firms develop internally standardized processes to assure compliance with these regulations. As with other activities, the pharmaceutical industry has concluded that such separately developed processes are not source of competitive advantage, and thus have been working to standardize best practices that are both shared by various competitors and also sanctioned (officially or implicitly) by the relevant regulators. In some cases, the standardization of these practices also includes an implementation of such practices (such as a quality audit).

The most dramatic example is Rx-360, formed in 2009 to assure supply chain quality for pharmaceutical companies and their suppliers. The consortium was founded in response to the dozens of deaths in 2008 from adulterated Heparin, when the manufacturer Baxter International was unable to detect counterfeit suppliers of an essential ingredient (West & Olk, 2016). The consortium both developed standardized processes for auditing such suppliers, and also helps Rx-360 member companies contract for shared supplier audits that are conducted by the British Standards Institution.

4.6 Other Quality Standards

Consistent with other research on quality standardization (Hemenway, 1975; Hallström, 2004), the pharmaceutical industry seeks standards for the quality of its outputs, and also the processes used to create such outputs. (Unlike the previous category, such quality standards do not create the process but are only a way by which such processes may be measured).

For example, the International Pharmaceutical Privacy Consortium (founded in 2010) is focused on efforts to protect the privacy and security of data regarding the privacy of data related to clinical research; because their data will be used for regulatory filings (and often journal publications), patients in these trials face different privacy issues than ordinary patients (whose privacy in the U.S. is covered by the Health Insurance Portability and Accountability Act). The consortium has developed white papers and worked with regulators to refine standards intended to protect and safeguard the privacy of such patient data.

5 Discussion

The paper describes the preliminary results of a study of standardization consortia in the pharmaceutical industry as examples of coopetition that creates inputs enabling open innovation. It provides another example of industry-specific standardization (cf. Markus et al, 2006), and thus extends our understanding of standardization beyond the oft-studied computing and communications industries.

In particular, it provides an insight into voluntary collaborative industry standardization in a sector not usually thought of as being an active participant or supporter of such activities. The identification of 34 standardization-related consortia (out of a broader sample of 87 biomedical consortia) suggests the importance of such standardization in this sector.

The paper uses these 34 consortia to offer a taxonomy of six different categories. Using Hemenway's (1975) bifurcation of compatibility vs. quality, I identify three categories for compatibility: two for quality and one for both. Not surprisingly, three of the four compatibility categories relate directly to standards for information technology or information interoperability: ICT standards, open source ICT implementation, and data standardization. Perhaps also not surprisingly, two other categories relate to quality standardization in an industry heavily regulated for quality and safety — those that create standardized processes, and those that judge the quality of products or processes. Finally, the most unusual category is the creation of standardized inputs for biomedical production, a consortium business model that is unproven and perhaps unsustainable.

5.1 Standardization as Coopetition

As noted earlier, by their nature standardization (and other) consortia involving competitors correspond to the principles of coopetition, in which firms balance the tension between cooperative outcomes that benefit all parties and competitive outcomes which advantage one party over another (cf. Brandenburger & Nalebuff, 1996).

The benefits of standardization consortia accrue both to specific firms and an industry (or economy) as a whole. The cooperative production of broadly shared standards provide shared benefits such as interoperability (Hemenway, 1975; Weiss & Cargill, 1992). Firms participating in standardization may also gain access to firm-specific benefits from that effort, such as access to tacit knowledge related to the standard or its underlying technology (West, 2007) or steering a standard in a way that directly benefits the firm (Bekkers & West, 2009). Finally, firms may gain indirect benefits such as strengthening industry ties (Rosenkopf et al, 2001) or favorable publicity (Blind & Gauch, 2008). These firm-specific benefits can potentially provide competitive advantage over non-participating firms, or even preferential advantages over other participants.

At the same time, firms incur costs of participating in standardization consortia that may vary by firm (Weiss & Cargill, 1992). The direct costs include cash payments (e.g. membership fees), as well as the use of employee time and other resources (West & Gallagher, 2006). Firms also worry about indirect costs of participation, notably the leakage of proprietary information to the common effort and to direct competitors, particularly the leakage of (hard to identify and control) tacit knowledge held by a firm's representatives to standardization (Blind, 2006). Firms face a tension between sharing knowledge that's relevant to the creation of the standard (or other cooperative outcome) and protecting knowledge that provides competitive advantage (Ritala & Hurmelinna-Laukkanen, 2009).

For many of the 34 pharma standardization consortia, the donated labor was the largest cost. Interviews suggested that volunteers might spend 10-20% of their annual labor on consortia business, which for VP-level pharma execs could exceed $50k per employee. For some standardized data compilation projects (e.g. the International HapMap Project), the donated labor of scientists comprised the entire cost of participation.

The direct costs of participation vary dramatically. Many consortia offer nonprofit or associate membership at free or reduced rates. As with ICT standardization, most consortia appear to use variable dues to maximize revenues from large firms, utilizing a sliding scale based on the total firm employment (Clinical Data Interchange Standards Consortium), revenues (Rx-360) or even R&D expenditures (Biomarkers Consortium, TransCelerate). Some distinguish by the member firm's industry, with higher dues for pharma companies (Pistoia). Although not all consortia publicly report their membership policies, the annual dues charged for the largest firms (for those that charge dues) range from $18,000 to more than $150,000; in an interview, one participant said their consortium charged large firms $500,000 annually, but that number was not publicly reported.

Such direct and indirect costs pale compared to the pharma industry's available resources. The industry has high gross and net profit margins, particularly for those blockbuster drugs generating more than $1 billion in annual revenues. The industry is increasingly dependent on such blockbuster drugs, and thus even a day's delay in bringing a drug to market can cost firms millions of dollars by reducing the window to sell proprietary compounds prior to patent expiration (cf. Cutler, 2007; Paul et al, 2010). At the same time, these high margins meant that firms were unwilling to cooperate until they faced increasing pressures from declining R&D productivity and financial performance (West & Olk, 2016).

5.2 Open vs. Oligopolistic Benefits

How does collaborating in cooperative standardization[2] impact a firm's competitive position? Prior research suggests at least three possible outcomes:

Public Goods. First, the benefits of standardization may be freely available to all; in economic terms, this corresponds to standards as a pure public good that is non-excludable and non-rivalrous in use; in these cases, the benefits of standardization accrue to active participants and free riders alike (Kindleberger, 1983). However, this risk of free-riders can lead to under-investment by private sources (Cargill & Bolin, 2007).

[2] Because our focus is on multi-firm consortia, here we exclude the case of single-firm proprietary standards, which are both sponsored and implemented by a single firm (Eisenmann et al, 2011).

Club Goods. The second case is when standardization participants gain significant benefits — such as access to tacit knowledge — often as a central aspect of the business model of the standardization consortium to convince firms to provide financial, human, and other resources to support the consortium's effort (West, 2007). In these cases, standards correspond to a form of impure public good sometimes referred to as a "club good" (Prakash, 2000)[3]. However, in those cases — as is common with industry consortia —where club membership is open to qualified members, firms outside the consortium may not choose to join if the incremental benefits of becoming a club member (rather than being a non-member free rider) are less than the cost of joining and participating in the consortium (Zhao et al, 2007). In addition, the preferential access to scarce knowledge may confer only a temporary advantage until such knowledge is codified and widely diffused — both inherent goals of such standardization (Blind, 2006).

Oligopolistic Cooperation. In some forms of standardization activities, member firms may overtly seek to create a standard that serves their own interests, both relative to other consortium members and non-members alike. A common flashpoint in recent practice (and thus research) has been over the impact of intellectual property (usually patents) upon the creation and use of standards. For example, member firms may choose to design a standard that requires a license to their own IP (Bekkers et al, 2002; Bekkers & West, 2009). Conversely, the consortium members may act as oligopsonistic buyers that impose restrictive terms on potential suppliers of such IP (Sidak, 2009).

In this study, the results of most standardization efforts are public goods widely available to domestic and foreign competitors, for at least three reasons. One is the normative effect of openness — both from within and outside the biomedical sector — that both motivated some of these collaborations and established an ethos of openness within them (Barnes et al, 2009; West & Olk, 2016). Although we lack direct evidence, it appears that the same industry pressures and shift in culture that prompted firms to cooperate also discouraged some firms (or firm representatives) from seeking direct competitive advantage from such cooperation.

Second, interviews showed that certain consortia — particularly public-private partnerships producing standardized data — are closely aligned to the principles of open science. In these consortia, the private (and public) money is used to fund research by academic scientists that (as such scientists are wont to do) will be published in the open scientific literature. For examples, several consortia were formed to catalog and disseminate genomic data that might suggest specific approaches to therapeutic medicine. One was the Biomarkers Consortium, in which industry, academic, nonprofit, and government scientists prioritize funding academic research into biomarkers that predict clinical outcomes such as cardiac health or liver damage (Interviews, 27 July 2015). Another was GAIN, which sought to establish standardized processes for conducting Genome-Wide Association Studies and was funded almost entirely by Pfizer (Interview, 14 Mar 2016).

Finally, open science has been the seed corn of pharma firms for decades (Cockburn & Henderson, 1998) and thus it is not surprising that that firms accepted (and government and academic scientists expected) that the results of such research would be disseminated using

[3] Some have argued that from a theoretical standpoint, firm-developed cooperative standards should be considered club goods. In reality, years of standardization research suggest that the existence of such excludability benefits is an open empirical question for any given consortium (see for example Baron et al, 2014). If these benefits are small or temporary, this suggest that the steady state allocation of benefits may be more accurately represented as a public good than as a club good. As a practical matter, competition (aka antitrust) laws restrict the degree to which consortia can impose membership restrictions that reduce competition (Anton and Yao, 1995) — effectively setting limits on the creation of a club good.

the norms of open science. However, the sharing of raw data by pre-competitive consortia goes *beyond* the norms of open science:

> Open data partnerships provide universal and free access to research outputs including results, data and sometimes materials…. The open data approach is in contrast not only to commercial emphasis on intellectual property rights, but even to classic open science in which only the final outputs are shared. (Perkmann & Schildt, 2015: 1134).

There are some exceptions. As with ICT standardization efforts (West, 2007), some consortia provide preferential access to members (i.e. club goods) to support their own revenue model by incentivizing firm membership. For example, Rx-360 will sell its member companies a supply chain audit service, utilizing the standardized processes that it developed. ELSIE provides access to its database on potential packaging-therapeutic compound interactions (such as plastic leaching from packaging to a pill) only to paying member companies.

5.3 Standardization, Value Creation and Competitive Advantage

With its focus on coopetition, this study highlights the differences in the ways that standardization provides value and provides a firm an opportunity to gain competitive advantage and capture value. At the same time, it suggests some differences between the ICT and other standardization efforts.

Standardization is clearly central to industry dynamics in the ICT sector. Years of research on anticipatory ICT standardization has shown how firms either create value by enabling diffusion of products, or how firms gain competitive advantage by influencing such standardization — or both (e.g. Langlois, 1992; Bresnahan & Greenstein, 1999; Garud et al, 2002; Keil, 2002; Russell, 2006; Simcoe, 2006; Leiponen, 2008). Standards are a requirement to sell certain ICT products, either to allow interoperability of communication (David & Steinmueller 1994) — or obtain a supply of specialized complementary assets (Teece, 1986; Bresnahan & Greenstein, 1999). In some product markets, standards also provide the opportunity to generate patent royalties (and thus increased profits) for firms owning patents required for implementing a standard — thus creating an incentive for firms to influence standardization to serve their private interests (Bekkers & West, 2009).

In other cases the ICT standard is essential to firm sales, but member firms gain only a temporary advantage until knowledge is widely disseminated. In these cases, firms compete not on the basis of such advantage but on more durable resources (cf. Sirmon et al, 2010).

However, in other industries standardization is important, but not central to the firm's value creation and value capture (Markus et al, 2006). This was true for most of the 34 biomedical consortia. In these cases, the impact of firm competitive advantage (or lack thereof) upon firm success will be less (Table 3).

Table 3: Alignment of Standardization to Firm Value Creation

		Centrality of Standard to Firm Business Model	
		Low *Complementary to value creation*	High *Central to value creation*
Opportunity for Sustained Advantage	High *Unique resources or competencies*	ISO-9000	Mobile phones Web browsers PostScript printers
	Low *Commodity implementations*	USB **Allotrope (customers)** **Rx-360**	MP3, Blu-ray players **Allotrope (vendors)** **ICGC**

5.4 Future Research

This study suggests several important opportunities for researching standards beyond the ICT sector. First, the nature of standardization cooperation (and competition) has tended to be studied in industry based on engineering-based industries such as software and electronics, rather than industries organized around open science from academic research. This study suggests that the nature of how firms utilize standardization will be different in these cases.

Secondly, standardization may be more complementary (rather than central) to the value creation activities of a firm or industry. While this study suggest possible implications of such differences, the nature of biomedical (particularly pharmaceutical) competition is so unusual that additional research is needed to test these implications in other industries.

More generally, Markus and her colleagues noted a decade ago (Markus et al, 2006), further research is needed on industry-specific standardization, and how the interaction between industry structure, value creation and other dynamics shapes the creation, adoption, adaptation and use of such standards.

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Managing Standards Radical Innovation Projects – The Case of Micro Combined Heat and Power

Paul Moritz Wiegmann

Rotterdam School of Management, Erasmus University
wiegmann@rsm.nl

Abstract: *Existing literature finds both positive and negative effects of standardisation on innovation. In this paper, we investigate how companies can minimise the negative impacts of standards on their innovation projects and maximise the positive effects. While extant literature identifies different ways in which standards can be developed and gives success factors for companies that are involved in these processes, it does not consider this in the context of using standards to support a specific innovation project. We analyse the case of a European manufacturer of heating systems to understand how a company can successfully overcome barriers that standards pose for its innovation process and turn them into supporting factors. This paper is based on preliminary results. Data collection is currently in progress.*

1 Introduction

Innovation and standards are often seen as contradictory – after all, innovation is all about creating something new whereas standards have the purpose to fix a solution in place. This view is supported by some findings in literature, both regarding standards' effects on the development of new products or technologies (Abraham & Reed, 2002; Kondo, 2000; e.g. Tassey, 2000) and regarding standards' impact on innovations' market diffusion (e.g. David, 1985; Tassey, 2000). On the other hand, literature also demonstrates that there are ways in which standards can provide important support to innovation, both in the process of developing a new product or technology (e.g. Blind, 2004; Swann, 2010; Tassey, 2000) and in its diffusion to the market (e.g. Farrell & Saloner, 1988; Swann, 2010).

It follows on from this that companies facing standards during their innovation activities would want to maximise their positive effects and limit the negative influences. To do so, they can influence the content of standards and / or attempt to get new standards passed that remove hurdles and support innovations. Extant literature identifies three different modes of standard development (e.g. Büthe & Mattli, 2010) as well as some factors that can support companies' success in reaching their goals when engaging in standard development (e.g. den Uijl, 2015; Jain, 2012; Leiponen, 2008; van de Kaa, van den Ende, de Vries, & van Heck, 2011). However, this literature is neither complete, nor does it specifically address how companies can influence and manage standard development in the context of an on-going innovation process. Our paper therefore investigates the following research questions: *How can companies overcome standard-related hurdles to their innovation projects? Can such barriers be turned into supporting factors?*

To answer these questions, we study the case of a European manufacturer of heating systems. This company encountered several standards in a radical innovation project – some of which supported the innovation and some of which posed barriers to the project that needed to be overcome. Additionally, some standards that were needed to support the innovation did not exist at the project's beginning. The company actively influenced the further development of standards to ensure that it could overcome the hurdles and achieved an outcome where standards supported the innovation's development and its diffusion in the market. By using a case study approach, we are able to generate some novel insights, both into how standards can successfully be influenced and how this relates to an on-going innovation process. Rather than testing hypotheses related to individual aspects of such a process, we therefore provide an overview over an entire successful case and identify aspects that are promising for further testing. Additionally, our findings are expected to be useful for practitioners who find themselves in an innovation project where standards play a role. However, it should be noted that this paper is based on some early insights into the case and that the results presented here are therefore preliminary.

The remainder of this paper is structured as follows: In Section 2, we provide an overview over the literature about impacts of standards on innovation and standard development. In Section 3, we briefly outline the methods used in our study. Section 4 provides a description of the case and Section 5 contains a discussion of our findings and the conclusions.

2 Literature Review

We begin our literature review by summarising what has been written on the relationship between standards and innovation so far. Following this discussion, we provide an overview over how companies can influence the further development of standards to reflect their interests.

2.1 Standards and Innovation

Standards, which according to de Vries's (1999, p. 15) definition specify "a limited set of solutions (…) to be used repeatedly", appear at first sight to oppose innovation, which aims to create new solutions rather than re-use a limited set of existing ones. In a systematic literature review, Dahl Andersen (2013) found many different ways in which standards can impact on companies' innovation activities. Despite the wide-spread expectation that standards limit innovation, around 60% of the papers analysed in this literature review found that standards affect innovation positively. In the context of our study, it is particularly relevant to consider the impact of standards on the new product development (NPD) process and on the diffusion of a new technology / product in the market as these are the two most immediate effects of standardisation likely to be encountered by a company that is innovating.

2.1.1 Standards in the New Product Development Process

Extant literature identifies several different ways in which different types of standards can impact on the NPD process. The most obvious way in which standards can influence development of a new product or technology is by limiting options that are available to its developers. Tassey (2000) argues that standards which require a certain performance level are less restrictive in this context than ones which prescribe a specific design. A similar argument is made for process standards which should outline goals of the process rather than specific ways of carrying it out in order to avoid limiting employees' creativity and motivation and thus their ability to come up with innovative ideas (Kondo, 2000). An additional role of standards can be to define testing requirements. Such testing requirements can, in some environments (e.g. the pharmaceutical industry), add substantial costs to companies' innovation efforts (Abraham & Reed, 2002). This is especially true if they are not internationally harmonised and therefore require several different tests to provide acceptable evidence of a product's performance for several markets (Abraham & Reed, 2002).

In contrast to these negative effects of standards on the NPD process, literature also finds that they can be supportive in some ways. A major benefit of relying on standards during a new product's development is that they can provide useful information (Blind & Gauch, 2009; Blind, 2004; Schmidt & Werle, 1998; Swann, 2010). This was also confirmed by the 2011 edition of the UK innovation survey where 4.8% of respondents (7.6% in high tech industries) named standards as an important information source in their innovation activities (Department for Business Innovation and Skills, 2012; Robson & Achur, 2012). This seems to be especially beneficial in networked industries where information from standards can help ensure that different parts of such a network work together seamlessly (Blind, 2004; Schmidt & Werle, 1998). Additionally, standards can also be used to disseminate results from basic research to facilitate their application in the market (Blind & Gauch, 2009). However, this positive aspect of using standards as an information source also seems to have its limits. Information contained in standards may be related to someone's intellectual property (Tassey, 2000), although this problem may be more pronounced for standards that come from sources where there are no requirements to make technologies included in a standard available under FRAND (fair, reasonable and non-discriminatory) terms to all parties. Additionally, information in old standards may be outdated and therefore create lock-in effects or limit the quality of newly developed innovations if there is a need to preserve compatibility with older technology (Swann, 2010; Tassey, 2000). On the other hand, Swann (2010) also finds that information in very young standards can hinder innovation activities, implying that standards are most useful as an information source for innovation in the middle of their lifecycles.

In addition to being a source of information, standards can also support companies' NPD processes by facilitating collaboration with other players. This was evident in the Boeing 777's development where standardised CAD data enabled different companies to jointly develop an airplane (Allen & Sriram, 2000). More general, standardised interfaces and measurements help companies concentrate on developing elements of complex systems, rather than creating the entire system (Chen & Liu, 2005; Tassey, 2000). In these complex systems, there is a reciprocal relationship between interface standards and innovation since these standards evolve based on companies' earlier technological decisions and then shape their further development (Chen & Liu, 2005).

2.1.2 Standards' Effects on Technology Diffusion

In line with the findings cited in the previous section, extant literature names both ways in which standards can promote an innovation's standing in the market and ways in which they can hinder an innovation in getting wide-spread diffusion.

Standards can support an innovation's entry into the market in several ways. Testing standards can help signal an innovative product's quality to the market (Tassey, 2000). Much more importantly, standards are able to help an innovation reach critical mass in the market quickly. Farrell and Saloner (1985) found that standards can help start a bandwagon by signalling to others that an innovation is likely to be adopted by many players. Additionally, an innovation that forms a standard is more likely to be demanded by public procurement which often can also help building critical mass (Blind, 2008; Edler & Georghiou, 2007; Rosen, Schnaars, & Shani, 1988). Standards can therefore help to "build focus and critical mass in the formative stages of a market" (Swann, 2010, p. 9). Additionally, the information aspect of standards that was mentioned in the previous section can also support diffusion of innovations. Standards can disseminate information about new technologies which then helps others to develop products that make use of this innovation (Blind & Gauch, 2009; Schmidt & Werle, 1998).

While standards can support an innovation's uptake in the market if they include this new product, they can also hinder diffusion if they prescribe a different solution or formulate requirements that are not met by the innovation. This can often lead to lock-in effects where users stay with an old technology, even though a better solution is available (Tassey, 2000). A classic example for this is the QWERTY keyboard which persists in usage despite better designs being available (e.g. Allen & Sriram, 2000; David, 1985).

2.2 Influencing Standards

As a first step in managing standards related to innovation projects, companies need to identify relevant standards. De Vries & van der Zwan (2008) develop a step-by-step approach for companies to identify relevant standards (how this can be used is illustrated in (de Vries, Willemse, & van der Zwan, 2008)). Once they have identified relevant standards, companies can most likely simply use available standards. However, they may need new standards and decide to actively influence their development to overcome any hurdles they may pose for the new product's development and diffusion in the market. Additionally, such involvement in the standard development process may enhance the supporting factors. Below, we look at what has been written so far on how standards can change. Then, we briefly outline the ways in which standards can be developed and summarise the literature that investigates how companies can successfully participate.

2.2.1 Updating Standards

Although standards are generally seen as something fixed, they often are adapted during their life (Egyedi & Heijnen, 2008; Schmidt & Werle, 1998). In a study of IT standards, it was found that 40% of standards in the sample were subject to changes at some stage in their life-cycle (Egyedi & Heijnen, 2008). Reasons for such changes may be innovation requirements, market strategy and natural changes across a standard's life-cycle (Egyedi, 2008), even though this can lead to added complexity; issues for standard implementation; and interoperability (Egyedi & Heijnen, 2008). Egyedi (2008) distinguishes between four different ways in which innovation can act as a reason for changing standards:

1. Standards are updated because users' requirements are evolving.
2. Standards are updated because it is anticipated that a new feature of a technology will become important in the future.
3. New technical developments require updated standards to be fully exploited.
4. New applications of existing technologies pose demands for standards to be developed further.

Egyedi and Blind (2008) identify three ways in which such changes can occur: Standards can change because they are implemented in a way that deviates from the standard in some ways ('implementation change'); they can be updated to reflect changed circumstances (e.g. by releasing a new edition – 'standard maintenance'); and they can be replaced by other standards ('standard succession') (Egyedi & Blind, 2008).

Edum-Fotwe et al. (2004) propose an additional method of how standards could change in response of innovation. They suggest that standards are seen as a guideline from which innovators are free to deviate. If such a deviation produces superior results, the standards should be adapted automatically (Edum-Fotwe et al., 2004). However, while this approach may work on a small scale, such as the one where it was observed by Edum-Fotwe et al. (2004), it implies that there is a single actor who can decide about changing a standard or that all stakeholders agree to the changes. This conflicts with Schmidt & Werle's (1998) observation of opposing interests in standardisation. Additionally, this may lead to frequent changes, thus increasing the prevalence of problems coming from changes in standards

(Egyedi & Heijnen, 2008) and eliminating the advantage of standards reducing transaction costs (Egyedi & Koppenhol, 2010).

2.2.2 Standard Development

Changes in standards in response to innovation are likely to be made in the same ways in which the original standards are developed. This development can take place before a new technology's development (anticipatory standardisation), during its development (enabling standardisation) or after the technology has already been developed (responsive standardisation) (Egyedi & Sherif, 2010). Literature identifies three ways in which standards can be developed:

1. *Committee-based standardisation* (often referred to as de-jure standardisation) where standards are being developed in standard developing organisations (SDOs), such as the International Organisation for Standardisation (ISO) or ASTM International. In these SDOs, experts develop standards through consensus (Büthe & Mattli, 2010; Gallagher, 2007; Narayanan & Chen, 2012; e.g. Tassey, 2000).
2. *Market-based standardisation* (often referred to as de-facto standardisation) where standards emerge from battles in the market between different technologies (Gallagher, 2007; Narayanan & Chen, 2012; Schilling, 2002; e.g. Tassey, 2000).
3. *Government standardisation* where standards are developed by the government (e.g. Büthe & Mattli, 2010; Narayanan & Chen, 2012; Timmermans & Epstein, 2010). This overlaps to some extent with regulation which can also define "a limited set of solutions (…) to be used repeatedly" (see de Vries, 1999, p. 15) and which the OECD considers to be an important way of standard development (Khemani & Shapiro, 1993). In Europe, according the New Approach, government should limit the degree to which it defines standards in regulation (Borraz, 2007) although cases like the standardisation of e-mobility plugs show that this involvement can nevertheless be extensive (Wiegmann, 2013).

In addition to these 'pure' modes of standardisation, literature increasingly finds that they can overlap and more than one of them can play a role in a single standard's development. Interaction between market-based and committee-based standardisation has been put forward game-theoretically (Farrell & Saloner, 1988) and – to some extent – also shown empirically (Vercoulen & van Wegberg, 1998). Others have also shown that there are cases where standards were jointly determined by committees and the government (e.g. Bekkers, 2001; Gao, 2014; Pelkmans, 2001), by markets and the government (Funk & Methe, 2001) or by all three of them together (Wiegmann, 2013). Additionally, while these modes of standardisation look relatively straightforward, there can be many different interests involved in these processes (Schmidt & Werle, 1998). Even if a proposed solution is clearly technologically superior, it may therefore be a difficult process to pass it as a standard (Schmidt & Werle, 1998). This therefore means that companies that want to influence standards in order to overcome barriers that they pose to their innovation efforts potentially have a large choice of ways in which they can attempt to do this and may need to overcome resistance from many other players.

2.2.3 Success-Factors in Standardisation

The existence of the three modes of standard development and their potential combinations mentioned above indicates that there are potentially many different ways in which companies can influence standards to support their innovation efforts. It is therefore necessary to identify practices that are likely to lead to a successful outcome for such an attempt. Existing literature proposes such factors for each of the three modes mentioned above:

Relatively little literature analyses how to successfully participate in SDO committees. Findings indicate that companies' participation in SDO committees can be strengthened by also participating in consortia where they can coordinate their action to achieve better outcomes (Baron, Ménière, & Pohlmann, 2014; Baron & Pohlmann, 2013; Leiponen, 2008). Additionally, companies should participate in SDOs on the international level, not only on the national level (Mattli & Büthe, 2003), develop a clear standardisation strategy and be conscious of what other committee-members expect from them (Jakobs, 2015). Isaak (2006) focuses on the individuals who represent companies and identifies how they can build up social capital in the long run that allows them to influence the process in committees.

Literature also formulates advice for committees as a whole to help the standards that they develop to become successful. While this is not directly targeted at individual committee members, it implies that they should influence the process in such a way that the committee as a whole can reach these targets. Committees should ensure that a complete set of stakeholders is represented (Botzem & Dobusch, 2012; Markus, Steinfield, Wigand, & Minton, 2006; Simons & de Vries, 2006), which should at least include the core stakeholders who are key for a standard's eventual success (de Vries, Verheul, & Willemse, 2003; Fomin & de Vries, 2009). Other factors for committee-success include avoiding conflicts (Jain, 2012; Simons & de Vries, 2006), training committee-members and chairs and appropriate uses of technology to facilitate the consensus process (Spring et al., 1995). Since standards are often anticipatory to some degree, it is also important for their success to ensure that they can accommodate further developments (Jain, 2012).

A much more extensive and complete literature exists on factors that can determine the outcomes of market-based standardisation (den Uijl, 2015; Schilling, 2002; Suarez, 2004; van de Kaa et al., 2011; van den Ende, van de Kaa, den Uijl, & de Vries, 2012). Van den Kaa et al. (2011) and den Uijl (2015) identify a large number of factors from literature which play a role in this context. Many of them, such as entry timing, availability of complementary goods or pricing strategy can be influenced by a company engaging in market-based standardisation.

Literature on how to influence government standardisation is also scarce. It is, however, likely that success factors for lobbying in general apply. Literature has found in this context that companies can increase their chances of success by being part of a coalition and by affecting the salience of the issue (Klüver, 2011). In the context of lobbying at European institutions, literature has also identified which types of actors are more or less likely to gain access and consequently successfully influence European policy (Bouwen, 2002).

2.3 Conclusions to the Literature Review

Our literature review shows that standards can both create barriers to innovation but also support companies' innovation efforts in some ways. The literature that we found on the topic only consists of 'puzzle pieces' looking at very specific types of standards and aspects of innovation. A comprehensive overview of standards' effects on innovation is therefore still missing. However, one conclusion that can already be drawn is that whether a standard has a positive or negative impact on innovation (e.g. whether it can fulfil its function to provide useful information and whether it supports or hinders the innovation's diffusion) most likely depends on its contents.

Consequently, companies that face standards as a barrier for their innovation efforts have a strong incentive to influence these standards' contents in such a way that these hurdles are removed and turned into support. In principle, changing standards is likely to be possible through the same channels in which they are developed. Literature on standard development suggests that standards can be influenced in many different ways through the three modes of standardisation or combinations thereof. However, the review of success factors in standardisation literature makes it clear that no comprehensive guidance on how to do this exists yet. A complete list of factors that companies need to consider to successfully influence standards only seems to exist for market-based standardisation whereas only some specific factors appear to have been researched so far in the context of the other two standardisation modes. Additionally, to our knowledge, no research exists on how to successfully influence the outcome of standard setting in cases where more than one mode is involved. Furthermore, the research that has been conducted on the topic is not specific to innovation and gives no guidance on how to integrate standard development activities into the development of a new product or technology. It therefore appears that there is a substantial gap in the literature regarding how companies can resolve standard-related issues for their innovation projects, despite the probable importance of this topic for innovation.

3 Methodology

We use a case-study approach to identify how companies can use standards and successfully overcome standard-related hurdles to their innovation activities and turn them into advantages instead. Such a methodological approach is seen as appropriate when trying to answer how a certain process works (Eisenhardt, 1989; Yin, 2009). To understand such a dynamic process in detail, we need a case where a company encountered standard-related hurdles to an innovation process which it then overcame successfully.

We found such a case at a European manufacturer of heating systems. This company conducted a radical innovation project where it encountered several standardisation- and regulation related issues that could have prevented the product from being released to the market if they had remained unresolved. To understand how the company overcame these barriers, we analysed documents related to the case and carried out an in-depth interview with the innovation manager who was responsible for the innovation project throughout the process and who is also leading the company's activities related to standardisation and regulation. We plan to collect additional data by interviewing more people who were involved in the company-internal development process and external stakeholders who the company dealt with during the process as well as analysing more documents related to the case.

4 Case Description

Our case company is a European manufacturer of heating systems. This company was searching for more energy-efficient technologies to succeed the condensing boilers that it has been producing. This search resulted in the development of the micro combined heat and power (mCHP) technology. The technology extends the functionality of a condensing boiler by producing electricity in addition to heat and hot water. To do so, it adds an engine that converts primary energy into electricity and additional control electronics to the components found in a normal condensing boiler.

This was a radical innovation for the company and the entire market. While the company was experienced in producing heating systems, this was the first time that it developed a product that generates electricity. Therefore, the company entered a new domain where it encountered technological issues and standards that it was not familiar with. It acquired knowledge in this area during mCHP's development and collaborated with several other key stakeholders to advance the needed technology and update standards as needed for the innovation. The development trajectory started in 2005 and resulted in the first mCHP units being sold in the market in 2010, aiming mainly at the replacement market for boilers in existing houses.

In the following section, we outline the roles that standards played for the project. We then continue the case description by giving an overview over the actions that the company took to ensure that standards supported mCHP's development and introduction to the market.

4.1 Roles of Standards for mCHP

Standards were important for the innovation project wherever there are interfaces between a mCHP appliance and other entities. These interfaces can be purely technical (e.g. connections between the device and electricity installations) but also related to other aspects (e.g., recognition of the product's quality by other parties)[1]. Standards related to these interfaces fell into three categories:

1. Existing standards that could be followed without any changes needed.
2. Existing standards that needed to be adapted in order to realise the envisioned functionality of mCHP.
3. Standards that did not exist yet but were needed to realise the envisioned functionality of mCHP or sell the technology in the market and therefore had to be developed.

Standards belonging to the first group were helpful in mCHP's development as they contained useful technical information. Especially for interfaces related to the electricity generating functionality of mCHP, where the case company had little previous experience, they served as a 'checklist' to ensure that all relevant technical aspects of an interface had been considered in the project and to highlight issues that needed attention. For example, the company benefitted from being able to rely on such existing standards when developing the safety mechanisms relating to shortcuts and switching the device off in emergencies or when dealing with how to measure the amount of electricity produced by the device.

Standards from the second group presented hurdles to the innovation project that needed to be overcome. For example, existing standards for electrical wiring in houses were written under the assumption that there would be only devices within a house which consume electricity but no electricity producing devices. This meant that these standards in their original form were a major barrier to the project since they did not allow for installation of electricity-producing devices in existing houses without major alterations to buildings' wiring. Changing standards, such as these, which were written under assumptions that did not support mCHP, was therefore essential for the company's ability to commercialise the technology.

Missing standards which fell into the third group also constituted an issue for the innovation project that needed to be resolved. An example of such a missing standard was the basic product standard. This standard contains fundamental requirements for a product in terms of safety, efficiency, performance etc. Due to gas products being heavily regulated and their inherently high safety risks, the lack of a product standard effectively prevents them from being sold in the market. Conforming to such a product standard leads to 'presumption of conformity', meaning that no further proof is needed is needed that the product follows the legal requirements. In this standard's absence, producers would need to prove the safety of each new product which they put into the market in an expensive, time consuming and complex process. As mCHP was an entirely new technology, there was no relevant product standard when development started. To resolve this issue, the company based the technology's development on the product standards for conventional condensing boilers and contributed to the development of appropriate standards for mCHP in time for the market launch.

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1 Additionally, some (mostly financial) interfaces between the product and the outside world were related to regulation, not standardisation. Discussing these is outside the scope of this paper.

Additionally, regulation and standards relating to connecting mCHP to the electricity grid started to be changed just after the development process due to external causes. Since the increased use of renewable energy sources places additional demands on the grid, new technical requirements were introduced. This meant that technical solutions which were originally required were banned in the updated draft regulation and standards. This caused some duplication of development work for mCHP and would either require fundamentally re-designing the appliance or further work to change the draft requirements to accommodate mCHP.

4.2 Identifying Relevant Standards for mCHP

The case company started considering standards at the outset of the NPD process. It actively searched for standards that it expected to be relevant for the technology. Initially, it focused on identifying product standards, safety standards and standards for technical interfaces. Following this, still relatively early in the project, the company also considered standards related to the appliance's recognition in the market (e.g. related to quality certification) and financial aspects of the product (such as how customers would be financially rewarded to the electricity produced by mCHP, although these issues were mainly related to regulation, not standards).

Being very experienced in developing heating systems, the company identified standards which were relevant for this aspect of mCHP from the outset. On the other hand, standards related to generating electricity were new to the company. This meant that it only could identify some relevant standards at the beginning of the project (e.g. technical standards related to connecting to the electricity grid and feeding electricity into it) and was constantly searching for other applicable standards as the technology's development progressed. For example, it then identified standards regarding domestic wiring as relevant to the product after the development had progressed somewhat and the project team started considering the question how to establish the link between mCHP and an existing house's electricity network.

Overall, the company identified around ten relevant areas of standardisation (e.g. counting the produced electricity, electrical safety or safely operating the engine) where it had no previous experience and six areas where standards needed to be developed further for mCHP's development (e.g. connections to the electricity grid or domestic wiring). The fact that there were several such areas which were central to the company being able to develop all indented features for the technology shows the importance of successfully managing standardisation in the project.

4.3 Partnerships with Other Stakeholders

In addition to identifying relevant standards at an early stage in the project, the company partnered with others very early on. These partners fell into different groups:

1. The company identified a technology company that had already been developing the engine for some time. This company became an important partner in development for the case company. The successor of this company also became the supplier of the engine. Other suppliers of components were also partners in developing the product.
2. After choosing mCHP as the technology on which to base the next generation of its products, the company invited some competitors to collaborate on developing the technology. While this seems counter-intuitive, the company took this step for three key-reasons. First, it expected that the technology would be more credible at market entry if several well-known producers of heating systems supported it. Second, it aimed to standardise some components across the different appliance producers to reach economies

of scales more quickly. Third, the company expected that this move would increase its chances to be successful in the needed adaptations of standards for the technology. By choosing these partners, the company wanted to avoid the image that standards needed to be changed for a single company which requires ‘special treatment’ and instead send a strong signal to stakeholders involved in standardisation that the technology enjoyed support by multiple parties.

3. Additionally, the company partnered with several other stakeholders, such as utility companies, that had an interest in the technology and became active in industry associations, such as COGEN Europe (an association to promote technologies that simultaneously produce heat / hot water and electricity) to support the activities promoting the technology.

4.4 Standardisation Activities in mCHP’s Development

The case company was very active to develop relevant standards further to support mCHP. Although the company was generally experienced in standardisation, it found that there were some aspects of the process that were new to it, especially the degree to which governmental bodies were involved. This, together with the fact that not all relevant standards were known from the outset of the project, made it difficult to formulate a clear strategy of involvement in standardisation at the outset of the project. The company therefore had to be flexible in its management of this issue to react to new developments.

Mainly committee-based standardisation and governmental standardisation were used to achieve the desired outcome in the case:

- Most standards related to technical aspects of mCHP were *committee-based standards*. The case company collaborated with the partners discussed earlier within committees at CEN/CENELEC (the European SDOs) and their national member bodies to develop these standards further. A second (although less important) example are standards for recognition defined by committees in industry associations. These committees define minimum performance requirements which form the basis of certification schemes to signal quality and energy efficiency to customers[2]. Existing performance requirements did not incorporate electricity produced by an appliance. Consequently, the case company, as a member of these industry associations, worked towards updating these requirements.
- The technical requirements for access to national electricity grids are laid down in laws that differ for each European country (although there are on-going efforts to harmonise these). They are thus developed through *governmental standardisation*. Additionally, the European Commission had a keen interest in standards that support its energy labelling regulation for mCHP and engaged in their development within CEN/CENELEC, meaning that there was some overlap between committee-based standardisation and governmental standardisation.

The case company was successful in getting support to adapt all relevant standards to accommodate the requirements of mCHP by playing an active role in the relevant industry associations and standardisation committees as well as in lobbying governmental actors. Major contributing factors to reaching this goal were the company’s close collaboration with partners and proactively considering standards from an early point in the development process onwards.

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2 These certification schemes were introduced when minimum performance standards for boilers were harmonized across Europe. The new European standards required lower minimum requirements than some of the old national standards, leading some national industry associations to develop certification schemes to signal to consumers which products were performing on the old national standards’ levels.

According to the company's own estimates, these activities accounted for several man-years of work and added around 3-6% to the cost of developing mCHP.

4.5 Impact of Updated Standards on mCHP

The successful adaptation of all relevant standards allowed the case company to overcome all significant standard-related hurdles to mCHP's development and market-release and turn them into supporting factors. Specifically, these changed standards supported mCHP in the following ways:

1. The updated standards enabled the company to sell products using mCHP in the market. For example, it is illegal to connect any device to the electricity grid which does not meet the requirements laid down in the relevant standards and regulation. Consequently, changing these standards to make allowances for mCHP was essential to market the product.
2. The updated standards made it possible for mCHP appliances to be installed in existing houses without any major changes to the building. For example, the changes to the domestic wiring standards mean that these appliances can be integrated into a building's existing electrical installations rather than requiring them to be extensively altered.
3. Updated testing and performance calculation standards enable the company to credibly demonstrate the benefits of mCHP to customers, installers and authorities.
4. Updated performance calculation standards also allow for mCHP's electricity output to be included in energy performance calculations of buildings. This may lead to additional benefits for the owners of houses in which a mCHP appliance is installed, such as subsidies being available for its purchase.

Especially the first and the second ways in which the new standards support the technology make it clear that influencing the standards was a necessary condition for the case company to be able to successfully release the innovation to the market.

5 Discussion and Conclusions

Following our description of the case, we discuss these findings. We first consider the impacts that standards had on innovation in our case. Then, we discuss the lessons that can be learned from how the company managed these impacts and overcame barriers to the innovation project related to standards. Finally, we outline some limitations of our study and discuss its implications for further research.

5.1 Impacts of Standards on Innovation

Our case mostly confirms the effects of standards on innovation that have been found in the literature cited earlier. We first look at the effects that standards had on the NPD process before turning to what can be observed in the case regarding market entry.

In line with extant literature (Blind & Gauch, 2009; Blind, 2004; Schmidt & Werle, 1998; Swann, 2010), standards served as an important source of information for the NPD process in the case. Especially in areas where the company had no previous experience, standards could serve as a 'checklist' of issues that needed to be considered in the technology's development. Literature states that this standards as an information-source are particularly relevant in networked industries as they allow different actors to make components that then seamlessly work together in the network (Blind, 2004; Schmidt & Werle, 1998). This finding is also supported by our case. Most of the standards which were useful information sources in mCHP's development referred to interfaces between the appliance and other entities (e.g. the electricity grid or buildings' internal electricity networks).

Although the case shows that standards can contain very useful information for the development of a new technology, it also shows that the usefulness of this information depends to a very large extent on the contents of these standards. Extant literature relates the usefulness of the information in standards mainly to their age (Swann, 2010; Tassey, 2000). However, in our case, the assumptions underlying a standard determined whether it was useful for the innovation. While a standard at the end of its life cycle is likely to have more out-dated assumptions than a young standard, these assumptions' validity is not directly linked to the standard's age.

We also observe effects of standards on an innovation's introduction to the market. In line with the reviewed literature (David, 1985; Tassey, 2000), the standards that the company initially encountered could have created lock-in effects and could have blocked mCHP from entering the European market (see the last section of the case description for how these standards could have prevented market entry). This danger of lock-in was overcome by updating the relevant standards so that the underlying assumptions reflect the needs of mCHP. These updated standards also included testing and performance measurement standards which helped the company to credibly signal mCHP's qualities to the market, in line with Tassey's findings (Tassey, 2000). However, the case also shows that testing and performance measurement standards are only supporting an innovation if they reward the new technology's additional benefits.

5.2 Managing Standards in Relation to Innovation Projects

While the case company could rely on standards that supported mCHP from the outset by simply implementing them, managing standards that were presenting hurdles to the innovation or were missing required an active approach. In this respect, the case confirms literature's findings that standards can be adapted during their life-cycles to enable fully exploiting new technological developments through releasing new editions of existing standards (Egyedi & Blind, 2008; Egyedi & Heijnen, 2008; Egyedi, 2008; Schmidt & Werle, 1998). The company managed to achieve such updates to standards that proved to be hurdles to its innovation process by engaging in standardisation simultaneously to mCHP's development, thus using an 'enabling standardisation' approach (see Egyedi & Sherif, 2010).

Although the company's actions in managing standards' impact on its innovation project can therefore be classified in very broad terms using existing literature, we also observe specific actions taken by the company which contributed to the case's successful outcome. Specifically, these actions relate to planning this management action and identifying the right partners.

5.2.1 Planning Management of Standard-Related Hurdles

As indicated by some existing literature (de Vries & van der Zwan, 2008; de Vries et al., 2008), companies need to actively identify which standards are relevant for them in an innovation project. Doing so avoids being blindsided by standards when it is too late to actively manage them and instead allows companies to take the right action (i.e. either implementing them or trying to adapt them) in time. While this existing literature (de Vries & van der Zwan, 2008; de Vries et al., 2008) outlines a step-by-step approach for finding these standards, it does not make any statements regarding how this fits into the general innovation process.

Our case shows that that standards can affect fundamental decisions in developing a new technology (an example for such a basic decision in mCHP's development that was affected by standards is how the appliance can be connected to the grid). This means that companies may either need to already base early design decisions on standards or – if standards need to be adapted – need to allow sufficient time to do so. Consequently, they should consider standards as early in the development process as possible. This leads to the following proposition:

Proposition 1: Considering relevant standards early in the innovation process leads to a higher chance of innovation success.

While companies looking for relevant standards early on can follow the approach that was already described (de Vries & van der Zwan, 2008; de Vries et al., 2008) to do so, they are still unlikely to already find all relevant standards at the outset. Although the case company did use a systematic approach to identifying standards that might affect mCHP, it still found additional ones later on. During the initial search, it found all standards related to aspects of mCHP where it could build on its previous technological experience. In its search for standards that were relevant for the appliance's electrical part, where it could not draw on its experience, the development team encountered additional standards as it became more familiar with the design-issues to be solved for the technology. For example, it was not clear from the outset that standards related to buildings' internal electricity networks would be relevant. It therefore seems to be challenging – if not impossible – to identify all applicable standards for a radical innovation that is new to a company from the beginning of a project. This would also mean that it may not be possible to formulate a detailed strategy for managing standards at the outset in a radical innovation project. We therefore formulate the following proposition:

Proposition 2: The higher an innovation's newness to the company, the lower the company's ability to identify all relevant standards at the outset of the process.

Following on from the difficulty of identifying relevant standards from the project's beginning on one hand, and the need to avoid being blindsided by standards that are important for the development on the other hand, companies should scan the environment for relevant standards continuously throughout the project. If the case company had not done this, it would have been blindsided by the standards that it could not initially identify and would have experienced problems from developing a product which would not have matched the relevant standards. Additionally, the case also shows that relevant standards for the innovation can change while the NPD process is under way (see Section 4.1). This means that, even if a standard has been identified as relevant at the outset of the NPD project, a periodic review is needed to verify its contents and ensure that the new product is still being developed in line with standards' requirements. We therefore formulate the following, final proposition related to identifying relevant standards:

Proposition 3: Actively monitoring already identified relevant standards and searching for new ones throughout the project increases chances of innovation success.

5.2.2 Involvement in Standardisation

Once an innovating company has found relevant standards and established whether they are supporting or hurdles, it needs to determine how to proceed. If some of the identified standards need to be adapted to support the innovation, the company must become actively involved in standardisation. Edum-Fotwe et al. (2004) give the most concrete advice in extant literature on how to do this in an innovation context. However, their solution would clearly have been unworkable in our case. The case company encountered far too many stakeholders (often with competing interests) to be able to automatically get its new solutions accepted in standards. It is therefore doubtful whether Edum-Fotwe et al.'s (2004) approach to managing standards for innovation works in cases where standards define interfaces used by many stakeholders.

Instead, standards need to be adapted in the same way in which they are developed. This means that, after identifying standards which need to be updated to accommodate their innovation, companies need to identify where these standards were developed and become active in these modes of standardisation. This is also what the case company did: To influence the further development of standards related to mCHP, it became active in relevant committees and industry association and lobbied governmental bodies. Success factors for developing standards in these contexts that we found in our literature review also apply in this context (Baron et al., 2014; Baron & Pohlmann, 2013; Botzem & Dobusch, 2012; Bouwen, 2002; den Uijl, 2015; Klüver, 2011; Leiponen, 2008; Markus et al., 2006; Mattli & Büthe, 2003; Simons & de Vries, 2006; Suarez, 2004; van de Kaa et al., 2011; van den Ende et al., 2012).

Although most (if not all) success-factors from previous literature may apply in this context, one stands out in our case. It appears that much of the success of the case company in updating standards to accommodate mCHP was due to its extensive partnering with other stakeholders. Extant literature sees partnering as important to be able to develop common positions in SDO committees (Baron et al., 2014; Baron & Pohlmann, 2013; Leiponen, 2008) or because the relative sizes of lobbying groups can influence lobbying success (Klüver, 2011). While these factors may also have played a role in our case, partnerships made additional contributions to successfully changing standards. The company's partners covered a diverse set of stakeholders, including competitors, suppliers and others with an interest in the technology. This sent a strong signal, both to other actors in standardisation and the market, that there was broad support of mCHP. Additionally, these diverse partners were able to cooperate in the standardisation efforts and the R&D of mCHP, contributing their specific expertise.

The – at first – most surprising element of this involvement of other parties is the company's choice to partner with its competitors and involve them in the development process of mCHP. This goes against common wisdom which would suggest that a company keeps a radically new technology to itself as a differentiator in the market and attempts to implement strong IPR protection. This counter-intuitive strategy is explained by the importance of standards for the case. Since competitors are among the core stakeholders (de Vries et al., 2003; Fomin & de Vries, 2009) in the committees developing these standards, they could easily block the standard development necessary for market introduction. Additionally, broad support of the technology by well known industry players is an important sign to the market in starting a bandwagon and achieving market acceptance. Allowing them to benefit from the new technology is thus an effective way to secure market access without which a technology's initial developer also cannot reap any benefits from it. Hence, we develop the following proposition:

> *Proposition 4: Gaining support from a broad set of stakeholders – including competitors – is a necessary condition for adapting standards needed for an innovation's access to the market.*

5.3 Limitations and Further Research

Although our study offers interesting insights into how companies can successfully manage standards in relation to innovation and overcome hurdles that standards pose for an innovation project, there are some limitations which mean that further research is required.

First, this conference paper is based on preliminary results of our study. While this already offers novel insights into how companies can manage standardisation in their innovation projects, readers should therefore note that the study is still work in progress and should therefore not yet fully rely on the results.

An additional shortcoming of our study is that it is based on only one case so far. While the case company was clearly successful in managing standards related to the mCHP project, additional cases should be studied to add strength to our findings and further support the propositions that we derive. Following such a qualitative study, an additional quantitative study involving a large number of cases can be used to test these propositions.

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References on the Industrial and the Post-Industrial Ways of Cooperation for Development

Dr. Angelos Zachariadis

ENEPROT, Greece,
azach@arch.auth.gr

Kanella Chatzimichail

University of Macedonia, Greece
ba1240@uom.edu.gr

Aspasia Thoma

DRAXIS Environmental Technologies S.A.
aspasia.thoma@gmail.com

Abstract: *The starting-point of the activity of cooperation is far back in the prehistoric ages, as the social instinct which formed the herds in the animal world. Only in the human race the animal instinct of cooperation evolved to concious actions and formed the human societies. The cooperation activities have developed, following the evolution of the societies by the communication standards, which allowed the passing of the cooperation systems from generation to generation. The development of the human cooperation systems came to its pick by the shaping of the social system of Democracy in Ancient Greece. The development of the human societies, though, had not a stable path, through the time until the Industrial Revolution.*
The Industrial Revolution was a European matter. The roles in industrialization's prehistory changed dramatically, though, between East and Western Europe during the "Crusades Era". After the Industrial Revolution, during the Industrial Era, the industrial cooperation standards were differentiated from the traditional cooperation models, marked by the characteristics of the West European nations.
These industrial cooperation standards, planned for hudge sizes, machine-oriented mass production, and global activities, have led humanity to a climax of crises. The late global socioeconomic crisis, which marked the end of the Industrial Era, raised the need to form post-industrial cooperation models.
The postindustrial cooperation models can be formed in South-Eastern Europe, which, although had the main role in the beginning of the long history of industrialization, is still not affected by the Industrial Era's negative phenomena, as it didn't take direct part in the events of that time. The absence of the Balkans from the happenings of the Industrial Era constitute a positive element for SE Europe regarding the planning for a transition to the Postindustrial Era. Our aim is to highlight the potential of the Balkans to resume a role in the forming of Europe during the Postindustrial Era.

Key-words: *Herd, team, extension, history, cooperation*

1 Introduction

Cooperation is considered as every joint action of working or acting together for a come non purpose or benefit. The cooperative actions are indispensable not only for the development but as the main mean for survival. The starting-point of the cooperation activities is in nature, goes far back in the prehistoric ages, as the social instinct which formed the herds in the animal world.

By the evolution of the human race the animal instinct of cooperation was developed to conscious actions, and formed the cooperation models. Charles Darwin formulated the scientific theory of evolution by natural selection, based mainly on competition in the struggle for life. What Darwin meant with evolution by competition was mostly achieved by cooperation in nature, because evolution is not only competition but in large scale involves cooperation. Also artefacts and technical/virtual systems as “organisms” survive via cooperation standards and models. Variations of those cooperation models which come out after the first competition standards help the “organisms” to fit at the best to the environment by emerging and reproducing solutions to the next generations. In this way those cooperation models formed the first human societies, thanks to the appearance of the communication standards, which allowed the inheritance of the cooperation – systems from generation to generation of the humans.

The developing of cooperation-systems came to its peak by the shaping of the social system of Democracy in Ancient Greece. The developing, though, of the human societies had not a stable way or direction, following ups and downs, until the next turning point of human development, the Industrial Revolution.

During the Industrial Era, which began with the Industrial Revolution, all human models changed dramatically. As it has appeared nowadays, these changes had not actually followed the direction of developing the human cooperation systems, as industrialization was oriented more to the benefit of machines, financing, and trade, ignoring actually the human needs. The storming changes of the Industrial Era brought-up the unexpected problems, which are jet visible after the repeated crises.

Post-industrial society started actually in late 20th century. In technically advanced nations, was based mainly on the production and consumption of services and information instead of goods. In those Western societies’ new ways of thinking appeared where human being is really central player. It involves increased valuation of ideas and knowledge as new form of capital. These cooperation models thought involve only a limited part of Western societies. In general the societies of the technically advanced nations continue to work with cooperation standards of the Industrial Era.

There is an indispensable need to form immidetialy the models of the Post-Industrial Era, keeping in-mind the experiences of the Industrial Era and those of the preindustrial ages. Meaning that the forming of postindustrial cooperation models has to start by the analysis of their history.

The paper aims to highlight the potential of the Balkans to resume a role in the forming of Europe during the Postindustrial Era. Since the analysis of History is the first step for the planning of Europe’s Postindustrial cooperation models, we commence our presentation highlighting the History aspect.

2 Historic Analysis

The Ancient Greeks have given the meaning of the word history, which passed since that to the European Languages after the acting of ΙΣΤΟΡ – histor, who the person was narrating only those that he knew. And, as we know, all the facts which led to the Industrial Revolution appeared and happened in Europe. Therefore the Industrial Revolution, and the Industrial Era as well, are basically a European matter, and the characteristics of the nations of Europe were those which have shaped the industrial cooperation models. Although the West-Europeans were those that moved the world to industrialization, South-Eastern Europe had in the begging the main role.

The role in the evolution of industrialization changed absolutely during the “Crusades Era”. The European history has a period, between the 10^{th} and the 13^{th} ages, with has not being defined jet. This period is crucial, though, for the cooperation systems. We have named this period “Crusades Era”.

During the European Crusades Era, appeared basic differences between the East and West of Europe. In Eastern Europe, already after the conquests of Alexander the Great, a kind of oecumenication was created. This oecumenication was extended by the Romans to the West, and then a globalization appeared for the first time in the European history.

Until then, the Macedonian extention of the Greek nations, the cooperation models were developing locally by the Greek city-states. In this way the cooperation models had some similarities in matters of inter-state cooperations, but had mostly a charming variety in the local characteristics. This made then, to be very well adjusted to their environment. The Romans later classified and coded these models to strict cooperation standards.

The difference between the Roman standards and those of Ancient Greece was that the Greek states were acting in their way, not trying to dictate their models to the conquered nations. The Greek models, though, having the brilliance of the Greek civilization, were copied as models by the foreigners. On the contrary in the Roman imperium all nations had to live under the Roman standards.

3 Pre-History of the Industrial Era

The Roman way of standardization passed to both the East and the West Roman Empire. In the Post-roman period, Eastern Europe, as the Byzantine Empire, was the spiritual and development center of Europe, having since 425, the first university in the world, the “Pandidaktirion” in Constantinople. The Byzantion took the first steps to industrialization during the 8^{th} century, when the first industrial cooperation system of Europe was created in the Byzantine territory of Venice.

The Venetian nation, (a tribe that came to Italy during the Roman Empire from the Baltic Sea and Polen) was driven to the islands of Adriatic Sea, at 600 AD, by the Lombards. When the Byzantine Exarchate of Ravenna was also conquered by the Lombards in 751, the islands were emigrated by the Byzantine refugees and started then, havy populated, to act as a Byzantine stronghold and trade center in Western Europe.

On these Venetian islands was then created, at the 8^{th} century AD, the first known in European history industrial complex. It was a channel, at the banks of which different work- and trade – shops we installed. Starting on the one end of the channel, the vessel of a ship was built, which was then thrown to the channel and was moved- along it. As the vessel was passing by the shops, all kind of armature, which was made or stored in then, was added to it. In this way when the Vessel arrived at the end of the channel, it was then a fully armored ship.

As Venice was evolving from a Byzantine territory to the first European modern state as a Democracy, in the channels’ industrial complex some basic industrial methods, such as interchangeability and multiple uses were developed. At the same time dramatic changes happened in the social cooperation systems of Europe (Chomsky, 1992, p. 44-46).

In the Western European States the feudal system emerged, by which the royal power was weakened and it was derived to a great number of rulers, who formed actually the later European states. This spreading of power was more likely to the Ancient Greek democratic cooperation system then to apolitarchy. Most of these West-European states were united by

Charlemagne to the "Roman Imperium of the German Nation", a catholic state-cooperation which had as coordinating center the Pope in Rome.

In the Byzantine Imperium of Eastern Europe the changes were in the reverse direction. Already during the Economachy period of the 8^{th} century AD, a great number of artists, technicians, craftsmen, even scientists emigrated from the eastern Byzantine territories to the western ones. Additionally the Byzantine coordinating system slope to an authoritarian one, as in the 11^{th} century AD the state division model of "Themata" was abolished.

As one of the authoritarian-changes results was the asking of Alexios the 1^{st} to the Pope to use West European soldiers to confront the Seltguke Turks in 1095. Pope Urvanus the 2^{nd} declared the 1^{st} Crusade which marks the begging of the Crusades Era and the transfer of Europe's center from East to West.

During the Crusades Era the authoritarian Byzantine Empire was gradually absorbed by the West – European feudal states. These evolutions were more dramatical in the industrialization sector. After Constantinople was occupied by the Crusaders of the 4^{th} Crusade in 1204, the West European rulers striped-out all the Byzantine industrial complexes and transported them, along with their workers and craftsmen, to their countries.

These emigrations at that time of scientists, artists, craftsmen and industries from the East to the West of Europe, might be the main cause of the West European "Scientific Revolution", which sparkled the Industrial Revolution in the Europe of the 18^{th} century.

4 The Industrial Era and the Industrial Cooperation Standards

The "Industrial Revolution" (1760-1860) was so named, in the late 19^{th} century, in order to differentiate its techno-economic motives in Great Britain from the social-motivated French Revolution. Basically though, they had the same spark. It was the deliberation of the religious fanaticism after the Enlightenment and its principal that God and Nature are the same thing. This principal was closer to the Ancient Greek believes on personalization of the Nature, than to the Christian and the Muslim preaching of the one and only metaphysical God.

These two European Revolutions which mark the beginning of the Industrial Era, have reborn the Ancient Greek principals in the West-European Nations. As far as the social cooperation models, the two revolutions projected the definite difference between the Ancient Greek Democracy and the Roman Republic. The cooperation model at the beginning of the Industrial Era was so the Democracy - and not the Republic - one.

As it is standardized, though, in human societies, the initial protypes-models do downgrade through the whole time of their implementation. It so happened with the cooperation models, which during the Industrial Era turned into industrial standards.

Some of the main differences of the democratic Cooperation Protypes-models to the Industrial Cooperation Standards are:

1. The democratic protypes are boned by those who will use them, as they are formed by their users as the model way to face the phenomena which are standardized by their repetition (Abeliotis & Siskos, 2006, p. 384).
2. As the protypes' users form them during the models' implementation, the feedback to the protypes' initial planning in ensured.
3. Having a constant feedback, the protypes have the ability to adjust to the changes of their application's environment.

4. As the protypes are formed by their users, their efficiency and their compliance to the main standardization principal of consensus is ensured.
5. The protypes have mostly the acting of a principal. Like principals, the protypes do not act as an accurate prescription of an action to be copied in an exact way, like the standards (Manual of Process and Procedures, 2005, p.7), but they act as a target adumbration which might not be achievable by humans. They impel in this way humans to develop their capabilities and to invent means (like machines) in order to come the closer possible to their target.
6. The human-formed protypes are oriented to serve the humans nature, needs, and capabilities and not these of the machines. One indirect ascendancy of that is the human environment protection and improvement pressure (Zachariadis & Damaskos & Zagas, 2010 p. 141).

At the end of the Industrial Revolution, most of the West-European countries, where USA was already added, had entered, after Great Britain and France, the Industrial Era. The cooperation of the West-European scientists, which was founded during the Enlightenment, despite the conflict of their countries at that time, was reinforced during the industrialization of the West. This human-cooperation brought up soon the industries-cooperation, and so the industrial cooperation standards started to be formed and to be implemented. It was a fact then, that standards helped the citizens to survive in a man-made technical virtual jungle.

Following the replacement, in all human activities, of the preindustrial models by the industrial standards, industrial cooperation standards sprawled, besides industrial production and distribution, to agriculture, economics, society, governance and education-research. These resulted to an interconnection of the institutions of the West, on the one hand, but also to an allocation (after conflicts) of the industrial demands between the Western countries (Zachariadis & Latinopoulou & Stergiadis, 2004, p 6).

The model of the industrialization in all fields was so amazing that soon overwhelmed the West. In parallel, industrialization, along with its cooperation standards, started to be diffusive by the West-Europeans to all of their colonies during the Western Imperialisms. During the 20th century, and especially after World War II, industrial cooperation standards, have gradually governed all the human activities globally. The globalization which resulted in this way, follows the one and only way, which is directed by the cooperation standards of the industrialized West (Chomsky, 1979, p.23-25).

5 Perspectives for Cooperation Protypes-Models of the Post-Industrial Era

The cooperation protypes, which are going to replace the relative industrial standards in the Postindustrial Era, must have the ability to prevent the dysfunctions that occurred in the Industrial Era's globalized development. Dysfunctions which were caused mainly from the characteristics of the West- European nations that drove the preindustrial cooperation-models to slide to industrial standards.

The first dysfunctions of the industrial cooperation standards appeared in their differentiation from the preindustrial models of the family, the cell of the human societies. This is apparent in the evolutions in Gr. Britain, the first industrialized country. The evolutions in Gr. Britain after the industrialization, were more or less followed by all the countries that came after, and in this way they were standardized. Always there, the problems caused by the industrial cooperation standards climb up to the whole society from its family-cell.

In Great Britain the "Fencing Act" had dissipated the crofters right before the invention of the first engine. When the machine-powered textile production started, this surplus of rural work power moved to the cities, turned to cheap labor potential and caused a violent urbanization. Besides, the cheap workforce enabled the huge accretion of the enterprises' mass- and the labors-numbers.

As interchangeability and the assembly – line methods simplified the work process, the workforce could be unskilled. This would transform craftsmen of the agricultural societies to be converted to unskilled industry-workers. As the male craftsmen were converted to unskilled industry workers, the main industry workforce was women and children). The firsthand results of the industrial cooperation standards were in the British families, with the degradation of the mail craftsmen and the independence of the working woman.

In the British society the social grading was no more based on human skills but mainly on the person's capability to adapt and act after the industrial cooperation- standards. The social model was then the one of the successful in work, and educated person, made of female. Besides the personal- overcame the social-interests (Gioblakis & Athanasiadis, 2004, p. 386)

Cheap workforce combined with a plethora of industrial devices enabled the enterprises to grow rapidly in size. The first home-enterprises which worked after contract – methods ("facon") in textile production, were absorbed by the plants. Gradually the smaller plants were absorbed by the bigger ones and these evolutions drove to the industrial – unit's gigantism, which, already in the 19th century, outgrew the British islands and spread-out in their colonies. When the social pressure (Zachariadis & Damaskos & Zagas, 2010 p. 139-140) brought restrictions in the Metropolises, the production and services centers were gradually transferred to the colonies.

The economic leap of Gr. Britain and U.S.A forced the rest of the European countries to turn to the same development direction. Mainly, after World War II, the industrial way of development was implemented all over the world and the industrial cooperation standards are nowadays enacted globally (Sodestrom, 200, p. 18). As this gigantism is the main cause of the Industrial Era's crises, the perspectives for the post-industrial cooperation prototype – models is to turn to the opposite direction (Polatoglou & Zachariadis, 2004, p.143).

The Postindustrial cooperation- protypes must:

1. Be oriented to locality instead of globalization.
2. Experiences of means for cooperation, such as information society and virtual reality should be exploited.

2. Proceed forward with the accommodation of humans and of societies to that of machines and industry.
3. In the society the social – dominate the individuals- interests.
4. Protect the natural and technical environment, here though in the global sense.
5. Be oriented to the cooperation of humans and not only of the technical means. At the same time the humans' cooperations should be based on the best combination of skills.
6. The cooperations should be graded in a general planning, graded from local to national level, in order to prevent wrong choices and fatal antagonisms in an unorganized environment. After the successful completion of the national cooperation plans, an international cooperation model could be built, as a global cooperation-network.

The general moto could be: "globalization in cooperation – locality in cooperations for human wealth, security, satisfaction, economy, as well as protection of local environment.

6 The Role and the Dynamic of South-Eastern Europe in a Development with Cooperation-Protypes

The Postindustrial cooperation-models can be formed in the Balkans, because they are not jet elected by the industrial Era's negative phenomena in an irreversible degree. As they were under the Muslim Ottoman regime, when in Europe's Christian West the Industrial Revolution took place, the Balkans got only recently acquainted with industrialization, by multipliers of the Western cooperation standards (Baltzaki & Karatzas, 1997, p.150). So all Balkans countries that emerged after the territory's liberation from the Ottoman Empire (the Ottoman's successor state Turkey as well) were organized after the West made cooperation-standardization (Theohanopoulos, 1997*, p.116).*

These evolutions resulted to a division of the development-ways in the Balkans, to that of the states' governance one, and that of the people. Even today the Balkan societies are more or less acting under the preindustrial cooperation models, when all levels of government are covered by multipliers of the industrial cooperation-standardization. Besides, the consuming mentality is directing to local cooperations and the agricultural sector remains strong, mostly as a bond of the people with nature. And most of all, the vast majority of the Balkan enterprises are family sized SMEs, where craftsmen and technicians have the main role.

That which leaves the Balkan SMEs undefended against the multinational enterprises (who have already set globally the cooperation-standards), is the lack of research, training, and scientific planning's means. The multinational enterprises, having huge economic potentials, can finance their own research and planning institutions, with high ranked personnel and devices. They can even set their own standards as means to protect the results of their research and planning.

On the contrary the SMEs having minimum financial and technological resources are unable to proceed autonomic. The only way to meet these needs, is the assistant by the State, which is thought given only financially, through the banks. The necessary cooperation of SMEs with the State research and educational institutions is totally absent. Another factor for this shortage is that research and educational institutions are managed mainly by multipliers of the industrial cooperation-standards, like in government, which cooperation standards are meant for multinational enterprises' measures.

What is needed in order to avoid that the cooperation is meant for multinational enterprises and technologies, and not for human capabilities, characters and mentalities, is a cooperation system, as a network (Manual of Process and Procedures, 2005, p.7) which will connect direct the SMEs with government's and research – education's institutions. The connection should be in such a way, that those who govern, those who research and those who teach will be selected after their personal abilities and skills, as the craftsmen and the technicians are, and not for their multiplier knowledge's (Baltzaki & Karatzas, 1997, p.154).

After such a kind of cooperation-protypes, the Balkan countries could get an unbelievable potential for the activities in Postindustrial environment (Zachariadis, 2004, p.103). The local SMEs will be able to coordinate as a huge assembly-line, in the sense of the Arsenale Nuovo of Venice. And each one of the technicians, craftsmen, scientists, academics and researchers engaged, will get his suitable role in the cooperation-activities, in the sense in the Ancient Greek Democracy. In this way the Balkans could get the dynamic of a European model for the Postindustrial cooperations.

7 Conclusions

The main means for the rational planning of cooperation-models is to follow all the way back the history of their evolution. The time, though, has in history completely different measures than its human conception .The conception of the starting-point of the cooperation-standards' development is the evolutions of industrialization in the West.

As the historical roots of an era go deep in the preceded eras, we consider that elements of industrialization are to be found in early human history, such as the prefabrication of bricks at 3000 BC in Middle-East. Cooperation standards go even further back in prehistory; and phenomena like globalization, of the Industrial Era's closing, had appeared at the end of the Classical Period of Ancient Greek history.

The European civilization has, at the starting-point of its history, two concepts; the Greek- and the Roman-one. Although they are referred as the one Greek- Roman civilization, they differ completely in many aspects. The European civilization started, following Christianization, after the Roman principles in East and West of Europe. The Ancient Greek principles seamed to vanish under the religious pressure.

Unexpected they were rebirth after the Scientific Revolution, which forced the Industrialization, and they are considered to be their spiritual background. As both the Scientific and the Industrial Revolutions though, were fulfilled in Western Europe, the Ancient Greek principles are still concepted after the Western-Roman prism.

The main finding of the paper is that the absence of the Balkans from the happenings of the Industrial Era constitute a positive element for SE Europe regarding the planning for a transition to the Postindustrial Era. On the basis of the above, the Balkans have the potential to resume a role in the forming of Europe during the Postindustrial Era and assist the planning of the European cooperation models.

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