UNTANGLING DISARRAY
- A META-ANALYSIS OF STUDIES ON STANDARDS AND STANDARDIZATION FROM A TWO-DIMENSIONAL FRAMEWORK

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ABSTRACT

In this paper, the fragmented literature and research on standards and standardization is organized and analyzed according to a two-dimensional framework. The two dimensions, being the level of analysis and the stage of the standardization process, serve as points of departure for the literature review. The analytical framework complements and extends existing literature and has implications both for theory and for management practice. Additionally, we also argue for theoretically grounded works within the field of strategic management, and suggest research topics that need to be addressed in order to take us one step closer to a comprehensive view of standards and standardization.
INTRODUCTION

Over the past decades, researchers and scholars from all corners of the world have engaged in and produced a significant amount of academic research and writing on the subject of standards and standardization (David and Greenstein, 1990, Cargill, 1996, Schmidt and Werle, 1997, Brunsson and Jacobsson, 2000, Spivak and Brenner, 2001, Blind, 2004, Gallagher, 2007, Tamm Hallström and Boström, 2010, Timmermans and Epstein, 2010, Blind, 2011, Buthe and Mattli, 2011, Narayanan and Chen, 2012). A large share of this work has been focused on various technological aspects, (Gallagher, 2007, Narayanan and Chen, 2012), but attention has also been directed to the importance of standards for organizational (intra-organizational and inter-organizational) development and change (Brunsson and Jacobsson, 2000, Tamm Hallström, 2004, Buthe and Mattli, 2011, Brunsson et al., 2012). In addition, the importance of standards for industrial dynamics has been approached from different theoretical perspectives (Narayanan and Chen, 2012; Brunsson et al., 2012), and the role of standards has been addressed from a sociological perspective conceptually, as well as empirically (Timmermans and Epstein, 2010). This multidisciplinary interest in standards implies their importance, but at the same time give rise to the question whether standards and standardization is a coherent field or not.

The aim of this article is twofold. Firstly, we aim to analyze and organize previous studies on standards in order to provide a framework for research on standards and standardization within strategic management. We argue that a specific strategic management perspective on standards is needed in order to identify relevant empirical and theoretical objects within this discipline. Secondly, we aim to identify gaps or inconsistencies, as well as insights, when it comes to research on standards within the field of strategic management. Based on this we will suggest research topics that need to be addressed in order to move forward to a more comprehensive view of standards.

A reader of the above-mentioned, and other related, work on standards and standardization realizes that the notion of standards, is multifaceted, and that their role from a research point of view can be emphasized differently depending on empirical circumstances and/or theoretical perspectives, but nevertheless share commonalities. The fact that standards encompass such a vast territory of “life” for individuals, organizations, societies and economies creates a need from a research point of view to apply a multidisciplinary angle, and focus on parts, while recognizing that the canvas limits the painting in respect to detail and motif. The word “standard” is used in various situations with slightly different meanings depending upon the context, sometimes used to express something absolute (for example a formal ISO-standard), but also a quality of relativity (something being of low or high standard). Very much depending on the domain that the concept of standards is used within, the meaning and need for precision varies. In management literature, scholars from different disciplines have studied standards, e.g. industrial organization economics (Blind, 2004), information science management (Brynjolfsson and Kemerer, 1996), organization theory (Brunsson and Jacobsson, 2000, Brunsson et al., 2012), and marketing (Chakravarti and Xie, 2006). The richness of literature and research is evident, but dispersed as already mentioned, among different academic domains.

performed by (Narayanan and Chen, 2012) (with a focus on technology standards); (Brunsson et al., 2012) (with an emphasis on organizational adaptation to standards); (Gallagher, 2007) (highlighting differences among standards and dominant designs); (Suarez, 2004) (proposing an integrative framework for understanding technological battles); and, (David and Greenstein, 1990) (surveying standard-setting processes). Although not exclusively, it is apparent that the majority of research has been directed towards various aspects of technology standards.

As already stated above, in this paper we aim to review research reports on the importance and relevance of standards in different settings where different theoretical perspectives and empirical objects have been used and focused. We examine previous research into the role of standards and standardisation processes, with the intention to connect previous work to the field of strategic management; for that aim the material is analysed and reported with the use of a two-dimensional framework that provides a structure and tool for identifying relevant concepts, theories and empirical objects regarding strategizing on standards and standardization.

This means that, from a strategic management-oriented perspective, the qualitative aspects of previous research have been emphasized rather than the quantity in reports of research. Nevertheless, in order to identify possible gaps in research findings, and basis for future research, the analysis also takes into consideration pluralities. In the process we have opted to reduce the emphasis on research with a focus on non-direct management orientation such as law (immaterial property rights, IPR) and (national) culture.

**What are standards and standardization?**

The richness of the existing research on standards is shadowed by a fragmentation and inconsistency the diverse use of standards-related terms carry (Narayanan and Chen, 2012). A brief demonstration of the used concepts in prevailing literature will offer the reader an overall insight into the notion of standards.

It is sensible to start with addressing the process that leads to standards. In the literature, there is no clear and unanimous definition of the standardization process – though significantly less dissimilar than that of the role of standards. It is clear that deviations in wordings occur, however synopsizing different descriptions results in conceptualizing standardization as the consensus process (Blind, 2004; Greenstein and Stango, 2007; Tamm Hallström and Boström, 2010) that leads to the institutionalization of an organizational practice, denoting its gradual and dynamic perceptive validation. Bowker and Star (1999) characterize it as an attempt to construct uniformity across space and time, leading to endorsed organizational guidelines, with those basically being the standards. In fact, it consists a negotiation process, which can either take the form of a deliberately formal decision making process (Brunsson et al., 2012) or emerge in the market, distinguishing between de jure and de facto standardization outcome (Funk, 2002). De jure standards are instituted “in anticipation of market competition”, whereas de facto occur as “the outcome of competition (Dokko et al., 2012). The terms refer to the pre-establishment period, could though be considered misleading since literally stand for ‘of law’ and ‘of fact’ (Latin origin, stipulated by Oxford Dictionaries). An authoritarian variance is inaccurately hinted, while on the contrary, a standard’s commandment has not much to do with the above classification - it is instead contingent with its predicated enforceability, addressed further in this article.

Instead of the heavily quoted but less appropriate ‘de jure’ term, a clearer one can be argued;
‘formal standards’, labeling the ones that emanate from the formal standardization process of a standardization body. On the other hand, standards that were not set by formal committees would consequently be called ‘non-formal’. Important to be pointed out is that ‘non-formal’ is not a synonym to ‘informal’, which is often used in the existing literature. The former expresses a voluntary, but purposive process, whereas the latter denotes a process that is in substance non-purposive and although it does have outcomes, they are usually not immediately visible (Chisholm, 2005).

Additionally, referring to the formal standardization and depending on who are involved – in terms of number, importance, expertise and type of stakeholders - a standard might have a low or high ‘input legitimacy’, assuming that greater participation guarantees a higher judgment and experience (Tamm Hallström and Boström, 2010), as well as a broader range of interests served. On the contrary, ‘output legitimacy’ denotes the diffusion of a standard upon its creation. The larger the diffusion, the higher the legitimacy signaled, leading to additional adoption rates.

Output legitimacy is in a sense related to enforceability. A standard’s commandment can be expressed in a continuous spectrum stretching from voluntary standards to explicit rules. If law is considered one edge of the continuum, meaning that is forced by authorities and non-compliance carries legal sanctions, then a standard’s mandate befalls strictly before the depiction as law. A standard is not a law since “no legal sanctions are imposed on non-adopters” (Brunsson et al., 2012). It is explicitly addressed that standards are not associated with sovereign hierarchical authority of states (Bernstein and Cashore, 2007), but ground on voluntary adoption (Blind, 2004; Brunsson et al., 2012). However, the fact that standards should not be considered formal regulation does not necessarily mean that they do not function as such. They have been described as ‘instruments of control’, ‘mechanisms of social order’ and ‘soft law’, with ‘soft’ underlining their voluntary aspect and ‘law’ implying that non-compliance carries consequences – despite them not being legal ones (Brunsson and Jacobsson, 2000; Djelic and Sahlin-Andersson, 2006).

It is often the case that standards notwithstanding their voluntary nature do intend to replenish regulatory gaps (Brunsson and Jacobsson, 2000). The complexity of enterprise and societal relations, highlighted by infamous scandals worldwide, such as ENRON, has called for regulation of their different aspects (Blom et al., 2012). Büthe and Mattli (2011) argued that in parallel with regulators’ lack of expertise and resources to deal with increasingly complex and urgent matters, international and private rule making has been primarily motivated by the economic benefits of global rules. Thus, governments limit the legal enforcement to elementary regulation and leave the rest upon law-like standards (Terlaak, 2007) whose enforcement is primarily not legal but still adequately effective (Pierce and Waring, 2004) mainly due to reputational mechanisms (Wymeersch, 2005).

Concluding the discussion of the general attributes of standards, it shall be mentioned that there is an overlap with dominant designs in literature. Some researchers used them interchangeably (e.g. Anderson and Tushman, 1990; Schilling, 2002) while others made efforts to distinguish them (e.g. Srinivasan et al., 2006; Gallagher, 2007). According to Suarez and Utterback (1995), a standard is often the result of a battle among technical alternatives, while a dominant design represents a broader notion, referring to any technology that establishes design dominance. Gallagher (2007) built on Funk’s (2003) conception to distinguish between dominant designs as persistent architectures and standards as interface protocols, stressing that highly important for standards is the concept of network externalities. Moreover, they often are important components of dominant designs.
A framework for review and analysis

In this section the method and the analytical framework that were employed in order to perform a literature review on standards are presented. Concerning the method, the approaches employed by Dahlander and Gann (2010) and Narayanan and Chen (2012) comprised initial inspiration. Primarily, a search based on the keyword “standards” was conducted, involving several databases such as Summon, Google Scholar, Web of Science and Web of knowledge. All studies conveyed were included in the reading list. Snowball sampling (Biernacki and Waldorf, 1981) was performed, meaning that the references in the reading material served as informants to enrich future sampling and track the most cited scholars - indicating that those ones have been the most influential. Snowball sampling ascertains that the scientific works that achieved core contribution in a field are successfully identified, even in the case that the initial sampling has missed to include them (Contandriopoulos et al., 2010).

Then, aiming at a framework of analysis that would identify and incorporate as inclusively as possible the patterns conveyed in previous standards’ research, two dimensions had to be taken into account. The first is the level of analysis, seizing differences between populations of firms (macro level) and the single firm (micro level). Another important aspect in standards’ discussion and analysis is the processual dimension, separating between the different stages of the standardization process. Both analytical dimensions are further explained in the next paragraphs.

Regarding the level of analysis, standards comprise a complex topic because their evolution involves both micro (firm) and macro (environmental) level forces. Moreover, the interface between micro (single firm) and macro (population of firms) appears to be blunt, since there is no clear and distinct borderline between them. Additionally, standards both “drive and are driven” by the actions of firms and industry associations, as well as agencies and authorities on an international arena (Narayanan and Chen, 2012). Consequently, three levels are employed, namely institutional, inter-organizational, and intra-organizational. This categorization according to level of analysis bears similarities to priory used frameworks, such as Astley and van der Ven (1983) and Narayanan and Chen (2012).

The first level, being the institutional one, rather precisely equals to the macro level. It refers to institutional constraints that can be political, social, or economic. Norms, relations, values and societal structures are in the center of attention, as well as how these evolve/change over time (Garud et al., 2002; Tassey, 2000). The importance of environmental factors is significant, either in the form of governmental action or of any other social mechanisms (Astley and Van de Ven, 1983). Typically no particular environmental element is dominant, nonetheless is the interaction of several factors, firms and groups that decides the final outcomes – one example being the establishment of standards (Suarez, 2004). Standards themselves are the output of a negotiation among relevant social groups (Hargrave and Van De Ven, 2006).

The second level, labeled inter-organizational (Evan, 1965) represents a collective of institutions, including economic organizations (firms). Institutional and inter-organizational levels are highly interactive. Collective of firms, which act on the macro level, develop and transform depending on each other’s impact. Inter-organizational environment is part of the institutional environment, and to a certain degree shaped by it due to industry structures and
dynamics. For instance, the emergence of a standard reflects the collective action of the firms involved in the process, creating not only standards, but also new institutional structures (Hargrave and Van De Ven, 2006; West, 2003). Suarez (2004) discusses how organizational communities support particular proposals, which after socio-political processes and negotiations within the community lead to the rise of a selected series of standards.

The third level is the intra-organizational level, which has been addressed already as firm level. Again the interactive relations are more than apparent. Institutional and inter-organizational level considerations are imposed on a firm due to social and competition/network pressures. Simultaneously, individual firms’ actions initiate and establish standards, through competition/network forces (Blind, 2004). Besides the external environment, namely institutional as well as inter-organizational settings, each firm is free and at the same time obliged to make specific choices and reach several strategic decisions.

The second analytical dimension used for categorizing previous reported research on standards and standardization is the processual, distinguishing between the stages of the standardization process. Those different phases are emergence, implementation and effects of standards. While the level of analysis points out the actors engaged in the standardization process, the stages are connected to the temporal dynamics of the process itself. Emergence of standards, which is the first stage employed in the processual analytical dimension, refers to the creation and development of standards and involves forces from all levels of analysis discussed above. Thus, an analytical approach that highlights the intersection between the processual stage of standards’ evolution and the respective level of analysis will facilitate the broad overview of standards’ research contribute to the task of defragmentation.

Correspondingly, the second stage is implementation of standards, which encompasses routes of adaptation, diffusion and use of standards. These routes and processes might bare similarities or differences across all three levels of analysis. As Narayanan and Chen (2012) argue, inspection of implementation requires comparing and integrating studies on different levels. Mapping of diverse approaches in previously reported research on the topic of implementation will expose linkages and overlaps between various levels, but also diversity across studies.

Finally, the third stage in the processual dimension is effects of standards. Again, taking into account the different level of analysis, the outcome of the standardization process must be measured and interpreted accordingly. Effects of standards on an institutional level might have linkages to effects on the inter- and intra-organizational level, but will not necessarily be manifested or measured in the same way. Establishment of infrastructural or cross-border standards is an example of an effect on the institutional level that creates circumstances on other levels. Inter-organizational agreements serve as factors for firms to operate on markets, and the use of standards within an organization may have cost-reducing or efficiency-enhancing effects. In the analytical framework used in this study it is argued that the intersections across both dimensions perform as useful lenses in the task to structure and map previous research on standards and standardization.

METHOD OF ANALYSIS

In order to analyze existing research on standards, the different studies were scrutinized and positioned within the presented analytical framework. Initially a categorization of the studies according to the first analytical perspective, namely the institutional, inter-organizational and
intra-organizational levels, was performed. Then, a second one, according to the processual approach, followed. Tables 1 and 2 show the number of papers categorized according to level of analysis and stage in the standardization process, respectively.

Absolute isolations of the studies in strictly one classification per analytical dimension would stand unrealistic attempts, therefore each study was allowed to be included in more than one level, depending on its content. Likewise, when a study addressed more than one stages, multiple coding was allowed for the processual analytical dimension as well. Otherwise, the multifaceted nature of standards and the interactive structures and relations would be overlooked, misleading the analysis. Narayanan and Chen (2012) similarly recognized in their review the fact that some papers “have more than one perspective” and followed the same practice.

Ultimately, the aforementioned coding process facilitated the attempt to perform a review of the multifaceted and complex concept of standards. A meaningful grouping of the papers in different clusters introduced order and structure in the diverse literature related to standards, by establishing points of departure for the theoretical analysis and setting concrete ground for prospect examination.

**Theoretical lenses and research methods**

The concept of standards has been approached from several theoretical approaches, providing further evidence that is complex and multifaceted (Brunsson et al., 2012; Narayanan and Chen, 2012). In order to perform a concrete review on the diverse literature related to standards, different theoretical perspectives utilized in the different studies, were identified and grouped in five separate categories. Those theoretical categories, comprising the five different “theoretical lenses”, served as a complementary structure for the analysis. In Table 3 the categorization of theoretical perspectives is presented.

Based on the categorization of the papers we examined patterns regarding the application of the different theoretical lenses in relation to the two dimensions in the analytical framework. This analysis showed in which extent different theoretical lenses have been utilized in different parts of the analytical framework. In Table 4 the theoretical lenses applied in papers categorized after level of analysis are presented, and in Table 5 the theoretical lenses applied in papers categorized after stage in the standardization process are presented.
In addition to the categorization of theoretical approaches, research methods used in empirical papers were identified and categorized according to the analytical framework. In Table 6 research methods used in empirical papers categorized after level of analysis is presented, and in Table 7 research methods used in empirical papers categorized after stage in the standardization process is presented.

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**ANALYSIS OF STUDIES ON STANDARDS AND STANDARDIZATION**

The review of published research into standards and standardization based on the two-dimensional framework described above revealed a number of patterns. In this section we present and discuss the analysis of the examined papers in accordance with the analytical framework. We commence by addressing patterns in definitions since variations and different emphasis intrinsically signal meanings and proposed use of standards on the different levels and in the different stages of standardization.

In order to identify topics, meanings and definitions used by scholars in the examined articles we searched for sentences and keywords that addressed what aspect of standards and standardization the different authors focused upon in their work. This resulted in a gross list of about 800 words or definitions (including identical, synonyms, and unique ones), with relevance to the concept of standards or standardization. We then ran descriptive tests in order to check for overall frequencies for the words/definitions. Next, we organized the papers according to the analytical framework and identified frequencies of words/definitions for each dimension in the analytical framework. We then identified the most common topics for each level of analysis, as well as each stage in the standardization process. Some topics were frequent regardless of level of analysis, and a number of issues were addressed across all stages of the standardization process. Regarding the levels, the following topics were frequently addressed in all three levels: technology, rules, governance, compatibility, and negotiation process. Regarding the stages for standardization the following were addressed frequently across all stages: compatibility, processes, technology, network effects, and formal
The process of identifying which words/definitions of standards and standardization were most commonly addressed in previous research served a number of purposes. Firstly, as mentioned in the introduction, the notion of fragmentation within research on standards to a large extent has been exemplified by the plurality of definitions of standards, suggesting that standards are not a coherent field. Secondly, specific research questions normally take as point of departure the aspects of standards that the researcher addresses, and these are expressed with the inclusion of definitions. Thirdly, the exercise also served as a test of the merits of the analytical framework applied in the analysis.

Finally, the examined studies that were examined are presented according to the framework in Table 10 below.

**Institutional level**

Research on standards with an emphasis on the institutional level, according to our overview, has to large degree addressed issues concerning regulatory aspects, governance and harmonization. Objectives and empirical objects vary among the examined research reports, and there are common traits as well as differences. Research, conceptual and empirical, aiming at increased understanding for standards and standardization on an institutional level has predominately approached the topic by utilizing institutional theory as theoretical lens.

Among the studies with an *institutional theory* lens Dokko et al., (2012) recognizes that organizations constantly change and evolve as a consequence of the interactions, adaptations and negotiations of their participants: social order is not stable. From the same theoretical standpoint Slager et al. (2012) states that standardization is a form of regulation, and standards are regarded as ‘instruments of control’. It is a continuous process, which is permanently supported by a set of micro-activities, involving a highly participatory activity and being a product of institutional work. In accordance with this, Guler et al. (2002), found that 1) states and foreign multinationals are the key actors responsible for coercive isomorphism, 2) cohesive trade relationships between countries generate coercive and normative effects, and 3) role-equivalent trade relationships result in learning-based and competitive imitation. Garud et al. (2002), with a focus on institutional entrepreneurship, argues that all standards have enabling and constraining effects, and are often forged through cooperation among competitors.
The above-mentioned work has circled around or targeted technical standards. Reports on research with emphasis on non-technical standards have also addressed the issue from an institutional theory perspective. Davis (1997) and Quinn-Allen (2000) examined the role of standards in education. Davis (1997), with bearing on the institutional level, concluded that an extreme decentralization of educational systems often works to subvert genuine innovation, and standards can serve as a means to improve innovation. These reports incorporate the cultural dimension and practice in the standardization process. Within that line of thought Tempel and Walgenbach (2007) stresses the focus on the influence of the societal or cultural environment on organizations (assumptions, beliefs and expectations that exist in society determine how firms should be organized), and a business-systems approach is useful since that focuses on the effect of a range of institutions operating at national level, on organizations.

Further, standards have been addressed from a specific sociological perspective with an institutional theoretical perspective. Timmermans and Epstein (2010) recognizes that increased globalization requires more standardization. Standard creation is fundamentally a social act, most standards are built collectively and, in order to work in a standardized way. Every standard needs to be plugged into a physical and cultural infrastructure that allows it to function. Countless standards do nothing. Some, however, obtain majestic results. By coordinating people and things in new configurations, standards transform, and their outcome is a transformed world (Timmermans and Epstein, 2010). To some degree this reasoning is supported by Valadez and Clignet (1984) arguing that despite the emphasis that highly technological societies place on the standardization concerning daily life, cultural systems identify the technological innovations that are acceptable. The cultural, or institutional, dimensions are also focused by Servais (2004) by addressing cultural concerns-and economic constraints in the wording of its conventions and recommendations. Servais (2004) states that the methods chosen to implement labor standards are predicated on culture and the standards drafted are universal, but cultural differences continue to strain the harmonious implementation of them.

According to our categorization of theoretical lenses used in examined research reports governance-related theory has served as perspective for the second largest cluster of reports with emphasis on the institutional level. On the institutional level, standards and standardization (in accordance with this theoretical perspective) functions as elements within a regulatory framework (Blind, 2008; 2011). The interface between the public institutions and the private enterprises are focused, and the standardization bodies play an intermediate role (Blind, 2008). Gerst and Jakobs (2005) complements this by arguing that standardization processes provide a platform where needs of the society can be efficiently mediated, providing standards useful and usable for all relevant stakeholders.

The role of standard setting organizations (SSO) for institutionalization of standards was studied by Simcoe (2011). A distributional conflict to SSO performance was found, concluding that SSOs do not have straightforward welfare implications. Welfare effects also depend on the technical quality of standards, which can be difficult to measure, and on the costs and benefits of alternative institutional arrangements, such as a standards war or platform leader (Simcoe, 2011).

Research on standards on an institutional level has also been addressing this from an organizational/behavioral theory approach. In the examined reports, non-technical standards have been in focus. Tenbrunsel et al. (2000) argues that standards are mechanisms that restructure incentives to induce individual responsibility and protect society. As such, they
have been described as effective in regulating individual and organizational behaviors that have untoward consequences, creating a just process, and raising public consciousness about destructive practices. Standards are beneficial, produce some positive results, and are better than no standards at all (Tenbrunsel et al, 2000). Perez-Aleman (2011) departs from the notion that existing organizational research highlights institutional factors to explain the international spread of quality practices, and suggest an additional explanation. Global standards serve to signal, initiate communication and to coordinate changes in another local context across organizations, diffusion though depends on collective learning (Perez-Aleman, 2011). Okhmatovskiy and David (2012) addresses organizational response to institutional pressure in their study and found that when faced with externally imposed standards, organizations can sometimes respond by developing alternative (non-technical) standards for the same practices. In addition, institutional organizational incentives for and effectiveness of standardization have been addressed by Blind (2002) in a study of national standardization organizations. Blind (2002) recognizes that standards are instruments for public policy in safety and quality issues to internalize negative externalities.

Among the examined work that was categorized as having impact for understanding standardization on an institutional level a few addressed the issue from an industrial organization perspective. Montiel et al. (2012) suggests that information asymmetries between suppliers and customers (that increase the transaction costs), can be reduced if suppliers signal through certification/standards. Furthermore, Montiel et al. (2012) argues that firms’ certification decision is not only affected by external pressures and internal firm characteristics but also by characteristics of the institutional context. David and Greenstein (1990) surveyed the contributions that economists have made to understanding standards-setting processes and their consequences for industry structure and economic welfare. Standardization processes of four kinds were examined, namely: (1) market competition involving products embodying unsponsored standards, (2) market competition among sponsored (proprietary) standards, (3) agreements within voluntary standards-writing organizations, and (4) direct governmental promulgation (David and Greenstein, 1990). Their conclusion was that there was little consensus regarding which means of standardization that had institutionalizing effects.

**Inter-organizational level**

Research on standards with an emphasis on the inter-organizational level has to large degree addressed issues concerning compatibility, coordination, network effects, and governance. Objectives and empirical objects vary among the examined research reports, and there are common traits but also differences. The majority of the research has addressed the role of market vs. organized efforts as a means to develop standards. Cooperation or competition is themes at hand on this level. Research, conceptual and empirical, aiming at increased understanding for standards and standardization on an institutional level has predominately approached the topic by utilizing organization/behavioral theory, industrial organization theory or governance-related theory as theoretical lenses.

The organizational/behavioral theoretical lens was the point of departure for Farrell and Saloner (1986) when addressing the question “do network externalities have an effect on the compatibility decision and inhabitance of innovation”, and concluding that network externalities might indeed create excess inertia and inhibit innovation even with complete information. Farrell and Saloner (1988) also found when examining common mechanisms for achieving coordination, with particular reference to the choice of compatibility standards, that
if an important agent makes a unilateral public commitment to one standard, others then know that if they follow that lead, they will be compatible at least with the first mover, and plausibly also with later movers. There may be legitimately different opinions about which standard would be best for the entire industry in the long run causing conflicts and negotiation processes (Farrell and Saloner, 1988). The interoperability factor was also addressed by Gerst, (2003) concluding that in order to ensure interoperability of systems in an increasingly networked environment of business partners, standardization on different levels is required. Furthermore, Gallagher (2007) concludes that the role of standards is narrowly driven by the relative importance of network effects while dominant designs are persistent architectures with established implications for industries. Funk (2003) found that installed base (number of adopters) does not appear to play the same role in the determination of dominant designs as it does in standards, because the network effects do not play as a crucial role.

The border between institutional and inter-organizational levels has been addressed in research on health and safety standards from an organizational theory perspective. One reported study is Bialous and Yach (2001) who examined the tobacco industry and standards regulating this industry. They found that the tobacco industry plays a major role in suggesting and determining the standards that are eventually adopted, and that other stakeholders in order to influence health standards need to coordinate and engage in standardization. In another study made by Manning and Von Hagen (2010) on the coffee industry, they concluded that standards resulted from project-based multi-stakeholder initiatives, vs. ‘public’ or ‘private’ actors. These initiatives targeted global standard development, regulating affairs and institution-building, and standards are a particular form of governance, non-binding voluntary rules. Institution-building projects are special development projects aimed at changing rules, norms and regulations, e.g. by setting standards (Manning and Von Hagen, 2010).

 Industial organization theory/theories has been another important perspective in studies on standards on the inter-organizational level. This perspective has been utilized in order to investigate into the mechanisms for standardization on this level. Cooperation among firms and coopetition as well as consortia and committee-based development are all examples of empirical objects studied by this approach, but also which role standards play in an industry. Argyres and Bigelow (2010) reported with relevance to the latter that market governance is efficient when transactions are relatively standardized and straightforward. In addition, Den Butter et al. (2007) reports that “proper design and implementation” of standards may lead to a considerable reduction of transaction costs, which enhances trade and, consequently, economic welfare. On the topic of standardization Rysman and Simcoe (2008) concludes that standards setting organizations increase the significance of standardized technology through formal endorsement and other efforts to promote industry coordination. Lehr (1992) reports that effective participation in standardization requires significant technical and business expertise, and that many of the features that lead to a slower process may be interpreted as an efficient institutional response to the problems posed by industry standardization. Furthermore, Tee and Gawer (2009) states that firms can manipulate industry architecture in association with platform establishment, and that standardization dynamics influence value creation and appropriation patterns in the industry. The formation of consortia and role of consortia in standardization has been addressed by Weiss and Cargill (1992). Standards serve to overcome the barrier to interconnection, which leads to the formation of consortia, and incentives exist for the formation of consortia both within and outside of the context of voluntary standards committees. These consortia can effectively augment the standards development process - or they can impede it (Weiss and Cargill, 1992).

Network effects, or network externalities, is another dominant theme at the inter-
organizational level where industrial organization theories have been applied in research. Matutes and Regibeau (1996) conceptually addresses this and states that compatibility promotes technological progress, but on the other hand the coordination problems associated with switching to a new technology can be exacerbated when previous generations have used a single standard. Schoder (2000) argues that, for technical standards, a significant factor in the occurrence of direct network effects is the definition of standards as well as the deployment of gateways, which provide compatibility at a cost.

*Governance-related* theories to a relatively high degree have been utilized in research on standardization on an inter-organizational level, for studying similar processes and configurations as industrial organization theories. However, coordinated formal standardization work where public institutions are included, and motives for and against multi-lateral organizing structures, are stressed in the examined studies with governance-related theories as dominating theoretical perspective.

Gerst et al. (2005) addresses the role of standards and states that for inter-organizational collaboration requires systems interoperability that is not possible in the absence of common standards. A challenge for inter-organizational collaboration is that standards appear to suffer significant transformations during implementation as users struggle to fit them to their specific needs and requirements. In order to manage and reduce transformation, coordination and monitoring across industry has to be governed. The possibilities to engage in inter-organizational collaboration is also dependent upon resources at hand in organizations, and SMEs hardly stand a chance to make their voice heard, which is an unsatisfactory situation as standardization and policy-making are mutually dependent (Gerst and Jakobs, 2005). Zhao et al. (2011) also addresses the coordinating aspect, but put forward the intrinsic coordinating aspect of (technical) standards. To handle the interoperability challenges and provide a common interface for communication among diverse systems, standards are “technical specifications designed to promote coordination” among the organizations within (or across) vertical industry sectors (Zhao et al., 2011). On the topic of coordination van den Ende et al. (2012) have found that successful standards showed more dynamic interactions between standard flexibility and network formation. The paradox of standard flexibility involves a temporary instability of the standard, but contributes to the standard's acceptance, which results in stability (van den Ende, 2012). Additionally, Reinecke et al. (2012) studied voluntary standards organizations and found that the on-going co-existence of multiple standards is being promoted by the interplay between two countervailing mechanisms: convergence and differentiation (Reinecke et al. 2012).

*Institutional theory* aspects of inter-organizational development of standards have been addressed by a number of the examined research reports. Choi et al. (2004) found that the ‘openness’ of standardization process helps to create a more comprehensive standard than proprietary standards, effectively leading to convergence of technologies. Moreover, the unfolding dynamics of standardization process varies depending on the characteristics of standards to be developed (Choi et al., 2004). Haack et al. (2010) in their study concludes that standardization must not be conceived as the passive adoption of homogenous practices but rather resembles an interpretative and dynamic negotiation process that involves the clash of different institutional logics within organizational fields. Manning et al. (2011) similarly found that institutional conditions and market opportunity structures have been important sources of standards variation.

A few of the examined research publications have direct *strategic management* implications in the sense that inter-organizational circumstances regarding standards for realizing strategy
have been topical. Blind et al. (2010) found in a survey that cost-related impacts are less relevant to stakeholders than various market shaping aspects. Stakeholders perceived the main positive impacts of standards in terms of the ability to increase product variety, and to develop new global outsourcing opportunities. Schilling (1999) implicates in her study that a firm could strategically influence certain factors, such as part-taking in inter-organizational collaboration, thereby improving its chances of success in a standards battle. Rosenkopf et al. (2001) provide supporting findings in their study where they conclude that joint participation by firms in technical committees helps them identify potential alliance partners and particular opportunities for technical collaboration. This effect is magnified by the sustained participation of specific individuals on behalf of their firms, demonstrating that inter-organizational relationships are enhanced by the inter-personal bonds that are forged in technical committees (Rosenkopf et al. 2001).

**Intra-organizational level**

In our analysis of the examined reported research on standards and standardization we found that empirical and theoretical objects as well as manifestations of standards shifted when we applied the analytical framework on the intra-organizational level. Definitions of standards and their applicability for organizations in research on standards within organizations highlight managerial concepts such as practices, routines, processes and quality (see Table 8). However, fundamental attributes of standards such as compatibility and interoperability are also relevant at the intra-organizational level.

Standards and standardization with emphasis on the intra-organizational level have in the examined reports been dominated by the theoretical lens of organizational/behavioral theory (theories), and one of the most discussed and investigated issues among these research reports is the issue of the role standards play in organizations. Standards are practices (Chow et al., 2001; Perez-Aleman, 2011); standards allow firms to reconfigure processes into sequences of standardized activities (Blind et al., 2012); standards are non-legal forms of regulation of business practices (Okhmatovskiy and David, 2012); standards ease organizations’ transactions and structure internal affairs as well as the world around them (Botzem and Dobusch, 2012); standards might aim at the creation of stability and sameness, standardization itself is a highly dynamic phenomenon (Brunsson et al., 2012); standards are mechanisms of social order, a hybrid form of control, incorporating properties of both formal directives and informal norms (Sandholtz, 2012).

On the intra-organizational level, standards and standardization has been researched from an *industrial organizations* perspective in particular in order to distinguish between the role of standards for a firm and the industry the firm operates in. Alliances, cooperation and contracting between firms in standardization work have been a topic of interest that has been examined from the perspective of industrial organization. Mayer and Argyres (2004), for instance, puts forward that over time the contracts between firms might serve as repositories of knowledge about how partners can efficiently work with each other in the presence of technological uncertainty and technological interdependence.

*Institutional theory* has been applied in a number of the examined studies. Garud et al. (2002) stresses that the standardization process generates temporary, partial agreements by interdependent parties with private and diverging interests, though engendering collective action is further complicated by inconsistencies between the initiatives required to mobilize a collective and the ones to maintain it. These tensions make it difficult for a firm to sponsor its
proprietary technology as a common standard (Garud et al., 2002). Tempel and Walgenbach (2007) put forward the merits of new institutionalism, which focuses on the influence of the societal or cultural environment on organizations (assumptions, beliefs and expectations that exist in society determine how firms should be organized). The business-systems approach focuses on the effect of a range of institutions operating at national level, on organizations, for standardization (Tempel and Walgenbach, 2007). Casile and Davis-Blake (2002) reports from a study on accreditation that, technical factors (potential economic gains from accreditation) had a greater effect on the responsiveness of private organizations, and institutional factors (diffusion through both social cohesion and structural equivalence) had a greater effect on the responsiveness of public organizations. Hence, institutionalized rationale must be taken into account in standardization. Haack et al. (2012) arrive in a similar conclusion in their study of CSR standards. They conclude that CSR standards are not necessarily characterized by homogeneous practices, societal consensus on their usefulness and moral appropriateness points to their heterogeneous implementation. There is no universal approach, standards must be customized to specific organizational circumstances (Haack et al., 2012).

Although the above-mentioned research has implications for strategic management, only a few of the examined reports addresses performance-related research on the intra-organizational level directly. Katsikeas et al. (2006) found when studying marketing strategies that standardization can offer economies of scale. However, their findings are inconclusive. Some studies indicate that performance is enhanced by standardizing marketing strategies across markets, while others reveal no association, and some studies report inverse relationship (Katsikeas et al., 2006). Zhao et al. (2007) concludes that firms’ payoffs from standard adoption increase with the intrinsic value of the standard, but developers’ benefits increase faster than passive adopters’ ones. Passive adopters, however, do not always exist (Zhao et al., 2007). In addition, Newburry and Yakova (2005) concluded after studying preferences of employees (in service industry) that employees from high power distance (i.e. who accept that power in institutions is distributed unequally among individuals), high uncertainty avoidance (feel threatened by ambiguous situations and try to avoid them through particular rules) and high context cultures (emphasize harmony, relationships and cooperation) prefer greater standardization, whereas employees from high individualism cultures (personal task accomplishment put before group interest) prefer less standardization (Newburry and Yakova, 2005). Furthermore, standardization benefits may include significant cost savings, consistency with customers, improved planning and control, and easier exploitation of good ideas (Newburry and Yakova, 2005).

Emergence of standards

Regarding the different phases of the standardization process, most papers displayed a joint analysis of two, or even all three stages of the process, with compatibility matters enduringly addressed. Some papers kept their focus exclusively on the emergence of standards, defining them as a form of governance or regulation, ensuring compliance and coordination. Specifically, Botzem and Quack (2005), Simcoe (2012) and Blind (2008) found that standards act as conducts of governance, managing interactions, and therefore applied governance-related theory. The former investigated into the emergence of international accounting standards and claimed that control of financial reporting is a highly political process involving diverse interests, thus needs to be systematized within an established procedural framework, while the latter ones are empirical studies, examining the circumstances that allow standard setting organizations to successfully coordinate standards emergence, as well as which fields are expected to call for standardization action in the future. Other empirical studies employed industrial organization to study the emergence of standards, such as Warner et al. (2006),
who suggested that firms can influence the emergence of standards in their benefit by acquiring targets with relevant technology, and Weiss and Cargill (2002), who discussed the role and impact of industry consortia in the standard setting process.

Organizational/behavioral theory are applied to explain mergence of standards in a number of reports. Bialous and Yach (2001) justified that the role and influence of tobacco industry was decisive in the emergence of standards of its interest, namely international standards for tobacco. Tenbrunsel et al. (2000) discussed that standards “exert an influence on judgments”, enhancing the cognitive attractiveness of proposals, even in the case that they were not superior, as long as they appeared to conform to a standard. Further, Manning and von Hagen (2010) found that significant role in universal standards’ emergence is played by global networks, which test new practices locally but coordinate the process internationally - as long as they manage to establish common ground. Blind et al. (2012) tested whether service industries, a sector of rising importance, participated sufficiently in formal standardization, and noticed that to a certain threshold R&D intensity motivates involvement. However, extremely innovative companies tend not to participate, possibly fearing spillover of proprietary knowledge. Relatively, Blind and Thumm (2004) analyzed the relationship between patent filing and formal standardization participation, finding an inverse tendency. They described this as problematic, since non-participation of innovative companies could result in the emergence of standards that lag behind the technological edge. Regarding the influence of specific firms in an SSO, Dokko and Rosenkopf (2010) connected it with personnel movement, as individuals with rich human and social capital affect the patterns of interaction and therefore the technological outcomes.

By applying institutional theory, Servais (2004) scrutinized whether increasing globalization urges for a reexamination of the dilemma between national or international regulation and how social relations are arranged, concluding that challenges arise due to cultural differences, despite that standards drafted are universal. Quinn-Allen (2011) questioned standards in relation to cultural considerations as well, pointing that desired results ought to be integrated with culture and goals, and that meaningful understanding is crucial. Valadez and Clignet (1984) used the example of housework to problematize standardization within daily life and cultural system settings, arguing that households merely reflect macro social processes, while Choi et al. (2004) examined industry consortia, finding that an open and collaborative process leads to more ample standards, with user participation being an essential factor.

As mentioned above, the phases of the standardization process are often examined together in literature. Regarding emergence and implementation of standards, organizational/behavioral theory was frequently used. Farrell and Saloner (1986; 1988), Blind (2002) and Okhmatovskiy and David (2012) stressed that network externalities, installed base and coordination mechanisms play major roles in the establishment of standards (Farrell and Saloner, 1986; 1988). In fact, standards appeared to be more effective and efficient in comparison to other policy tools (Blind, 2002), justifying why some firms choose to substitute externally imposed requirements with alternative standards, for the same practices (Okhmatovskiy and David, 2012). On the other hand, Felin and Foss (2009; 2011) discussed the origins and emergence of organizational routines - which arguably relates to standards - connecting new knowledge with endogenous concerns, such as experience and repetition, as well as environmental surrounding.

Paying attention to environmental pressures, Slager et al. (2012) and Garud et al. (2002) utilized institutional theory and reflected upon standards development, which often involves regulatory power, as an object of institutional concern. Sustained cooperation among parties
with diverging interests is unceasingly challenging, and requires social and political balance to prevent resistance and enhance maintenance.

Using governance-related theory, Gerst et al. (2005) explored characteristics and factors that shape the development and implementation of a standard, concluding that inter-organizational cooperation requires systems interoperability, grounded by common standards, which emerged and sustained through “communities of practice”. Zhao et al. (2011) discussed that member characteristics, specific resources, and realized benefits, are linked with each other and make it possible for voluntary initiatives to be sustained.

Through the lens of industrial organization, Lehr (2002) discussed that effective participation in standard setting requires significant technical and business expertise, since standards serve as formal technological means of compatibility. Additionally, active participation brings more benefits to the firm than passive adoption, according to Zhao et al. (2007) empirical study.

Another combination of stages examined is emergence and effects of standards, focusing on the technological aspect of standards. Industrial organization showed a frequent occurrence, outlining the importance of standards in industry configuration. Funk (2003) and Tee and Gawer (2009) found that firm involvement in the emergence of a standard affects the value captured afterwards, both due to information advantages and influence of the standardization process, in addition to incremental organizational learning reported by Mayer and Argyres (2004) and Argyres (and Bigelow?) (2010).

Governance-related theory was highly used as well, pointing that standards emerge through collaboration and also result in collaboration augmentation. Reinecke et al. (2012) examined how “meta-standardization” allows competition and collaboration simultaneously, through convergence at the level of core criteria and principles, but differentiation at the level of specialized attributes. Gerst and Jakobs (2005) remarked that “standardization processes provide a platform where needs of the society can be efficiently mediated”, indicating the interactive relationship of standards emergence and effects. This interactive relation was Greenstein’s (1992) focus too, who argued that standardization influences and likewise is influenced by market conditions. Market dynamics influence strategic interests, driving strategic choices, which in turn determine market outcomes.

A few scholars have tried to capture in their work all three phases of the standardization process, namely emergence, implementation and effects of standards, emphasizing network effects. Dokko et al. (2012), Feng (2003) and Davis (1997) used Institutional theory to examine social dynamics, since social order is not stable but constantly challenged by the interactions and negotiations of market participants. Manning et al. (2011) investigated the particular role of key stakeholders and argued that economic and institutional conditions have served as critical drivers of standards evolution globally.

Using organizational/behavioral theory Botzem and Dobusch (2012) highlighted that standards structure affairs, ease transactions and endorse coordination, while Brunsson et al. (2012) explained that organizations and standardization are connected since organizations’ activities are regulated by standards, which are in fact produced by those.

Implementation of standards

Research that focused solely on standards implementation is dominated by empirical studies employing institutional and organizational/behavioral theories. In the former category, Guler
et al. (2002) and Haack et al. (2012; 2010) aimed at obtaining a better understanding about the cross-national diffusion of organizational practices and guidelines, as they named standards. They claimed that trade relationships between countries generate coercive and normative effects, prone by a dynamic negotiation processes. The trajectories are not stable, but relational, and non-universal, but customized to specific circumstances. In the latter category, that of employing organizational/behavioral theory, Chow et al. (2001) and Sandholtz (2012) identified a distinctive cultural influence on standards implementation, both national and organizational. Boiral (2012) revealed that ISO certification could be a last minute and procedure-oriented preparation with often formalistic character, and Farrell and Saloner (1985) claimed that a superior standard might not be implemented if switching is costly and uncertain. Blind (2011) analyzed economic efficiency considerations with governance-related theory and stressed that competition authorities are responsible to affirm that formal standardization is not misused by competing companies. The only conceptual example in the implementation phase is Schilling (1999), strategic-choice oriented, contradicting conventional strategic perception by suggesting that competitive advantages could be generated by diffusing a valuable technology instead of protecting it.

Industrial organization displayed a high manifestation in papers discussing the implementation and effects of standards together. Montiel et al. (2012) empirically found that information asymmetries increase transaction costs, thus certification can be used as a signaling mechanism and reduce them, particularly urged by external pressures and institutional context characteristics, such as corruption. In the conceptual setting, Schoder (2000) and Cusumano (2010) underlined compatibility and network effects as major outcomes of standards adoption. Using institutional theory, Casile and Davis-Blake (2002) tested how public and private organizations react to changes in accreditation standards, and concluded that private organizations respond to technical factors, such as potential economic gains from accreditation, while public ones to institutional factors, such as social cohesion. Highlighting again the interoperability and networks effects, Gerst (2003) built the paper conceptually on organizational/behavioral theory and claimed that standardization on different business levels is necessitated in order to integrate inter-organizational processes in a progressively networked environment. Within the organizational/behavioral domain, but empirically, Gilson et al. (2005) uncovered that despite the seemingly conflicting natures of creativity and standardized practices, they can be complementary, while according to Galbreath and Moore’s (1997) findings, standards perform as useful guidelines though could appear to be ineffective.

Effects of standards

Finally, a number of studies addressed solely the effects of standards, with the largest majority of them employing the industrial organization lens. Compatibility, network externalities, transaction cost reduction and economies of scale were demonstrated as key effects of standards. Matutes and Regibeau (1996) pointed out in their conceptual paper that compatibility might boost or discourage R&D effort, since it promotes technological progress, but on the other hand could strengthen coordination problems linked with switching to a new technology when particular standard is vastly established. Den Butter et al. (2007), also conceptually, problematized the trade and productivity effects of standards. They reasoned that standards potentially reduce transaction costs via trust and mitigation of asymmetric information, at the same time that they can also moderate market failure via network externalities.
Foss (1996), Katz and Shapiro (1985), and Rysman and Simcoe (2008) tested empirically the existence of costs reduction and network externalities. Standards make possible both transaction and production cost reductions, while also give rise to demand-side economies of scale due to consumption externalities, meaning that consumers are willing to pay more if they foresee market dominance. Firms can themselves determine their network, by deciding whether to manufacture compatible products or not. Standard setting organizations have a saying on that as well, by contributing upon the establishment of new technologies. Another empirical study, Berger et al. (2012) applying organizational/behavioral theory, confirmed that patent applicants have incentives to delay the reach of a decision; at least until the standardization outcome is less uncertain. The goal of patent applicants is not necessarily to attain the broadest protection, but to accomplish a fit with the realized standard, which though hinders the motivation for R&D efforts - due to the risk of a patent being finally filed to a competitor after an artificially long process - and thus carries negative effects on the economy. A conceptual discussion about the effects of global standardization and management practices was provided by Tempel and Walgenbach (2007), who applied two approaches of institutional theory, namely new institutionalism and business-systems approach, claiming that complementarily they balance each other’s limitations. Taking the environmental context into account, Katsikeas et al. (2006) performed an empirical study in the domain of strategic-choice, reporting superior performance effects from strategy standardization as long as the strategic fit arises.

Economies of scale ensue, leading to cost reductions, which was the finding of Blind et al. (2010) as well, in the same domain. Formal standards were assigned cost impacts, which though appeared to be perceived by stakeholders less essential than other positive outcomes, such as the ability to increase product variety or new global opportunities. Likewise, cost savings associated with organizational practices were observed by Newburry and Yakova, (2006), who engaged a public-relations approach to study empirically the standardization preferences of professional service employees. Work interdependence was found positively related with standardization preferences, denoting that greater standardization is favored in settings of cooperation culture, high power distance, and high uncertainty.

**DISCUSSION**

The review and analysis of the standards literature presented above on one hand supports previous reviews on the subject in the sense that it accentuates a fragmentation of this literature, but on the other hand we argue that there are patterns and logics that makes the subject of standards, and research on it, more structured than has been reported in papers similar to ours. By applying the two analytical dimensions – level of analysis and processual stage in standardization – theses patterns and logics are revealed. Nevertheless, the broad picture on standards is that within the academic community there are differences in perspective, which are reflected in the flow of logic, the specific concepts that are raised, and sometimes even the research methods utilized in different streams. Evidence that standards and standardization encompass a coherent field for practitioners as well as scholars exist is not clear if contextual aspects are excluded.

An aim with the study reported here has been to relate previous studies on standards to the field of strategic management. This means that standards influence on an organizations temporal and spatial performance changes are of focal interest, but also that reasons and logic behind the development of standards must be considered. In addition, the decision processes leading to development and/or adoption to standards are of vital interest. The emergence of
standards occupies a focal point in all levels in the presented framework, however, as the analysis reveal, the three levels differ in terms of the flow of logics that underpin the explanation of standards emergence and development. A brief description of these differences follows:

On the institutional and inter-organizational level the emergence of standards is in previous research found to be driven by technological, institutional/environmental, and market factors, and even considered an external contingency, whereas on the intra-organizational level from a strategic choice view standards are the result of a firm’s proactive actions, captured by entrepreneurship and competitive strategies/resources. On the inter-organizational level the development of standards is characterized by an additive model combining both macro- (e.g., technological regime and institution) and micro-level factors (e.g., firm entrepreneurship and strategy).

The inter-organizational level is also concerned with other macro-level outcomes such as industrial structure (e.g., winner-take-all) and firms’ market entry and exit. Explicitly, negative aspects of standardization have been to a lesser degree of topical interest. However, in the decision making process, managers typically include different expectations or outcomes. A few studies focusing on the inter-organizational level have addressed micro-level outcomes such as participating firms’ performance. On the institutional level, the emergence of standards is not necessarily considered an outcome. A majority of the studies on the inter-organizational level have focused on the effectiveness of firms’ adaptive strategy in the face of standards.

The role of institutional/environmental factors is, in previous research, also addressed differently across the levels and stages in standardization. On the inter-organizational level, institutional/environmental factors (e.g., IPRs) are direct drivers of standards, but also contingencies. However, on the institutional level and intra-organizational level, these factors are modeled as contingencies influencing the impact of firm action on macro- and micro-level outcomes.

Firms’ resources are seen as relevant on the inter-organizational and intra-organizational level, but for different reasons. From a strategic management perspective on the inter-organizational level, a set of firm-specific resources acts as drivers to determine the outcome of a dominance battle or a standards war. In contrast, firm-specific resources are conceptualized as moderators on the intra-organizational level view to influence the structure-conduct-performance relationships. Firm-specific resources and capabilities are influential throughout the standardization process.

Future research from a strategic management view may further investigate how firms’ strategies shape industrial standards, and how industrial standards shape firms’ strategies. An arguably useful approach is to incorporate the action–response perspective (Chen, 1996). An action-response perspective puts the managers and the decision making in focus, and studies with this perspective can contribute to the understanding of value creation in firms through standards. Since firms’ competitive moves constitute the basic elements of inter-firm rivalry (Chen, 1996), revealing how firms’ competitive moves in the standards battle influence industrial standards and/or improve firm performance may help extend the understanding of standards. The temporal (if and when to adopt a standard) issues can also be addressed by research from this perspective.

On the inter-organizational level more research with focus on competitive dynamics can
provide a better understanding regarding standardization and strategic decisions. Further research that addresses the ‘co-opetition’ phenomenon can be singled out as a topic (Ketchen et al., 2007). Within strategic management research also needs to use a longitudinal perspective to examine the standard-setting and/or standards adopting firms. We especially need to know more about the period following the emergence of a standard. The competition in post-standard phase is often intense among firms conforming to the same dominant standard (Gallagher and Park, 2002; Suarez, 2004). It would be useful to design longitudinal studies to investigate these phenomena. In addition, research with focus on the inter-organizational level should shed light on the proactive roles of some entrepreneurial ventures in the formulation and retention of standards.
**TABLE 1.**
Studies in the sample, categorized after level(s) of analysis.

<table>
<thead>
<tr>
<th>Level of Analysis</th>
<th>No. of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional level</td>
<td>11</td>
</tr>
<tr>
<td>Inter-organizational level</td>
<td>17</td>
</tr>
<tr>
<td>Intra-organizational level</td>
<td>19</td>
</tr>
<tr>
<td>Institutional + Inter-organizational level</td>
<td>8</td>
</tr>
<tr>
<td>Institutional + Intra-organizational level</td>
<td>5</td>
</tr>
<tr>
<td>Intra- + Inter-organizational level</td>
<td>11</td>
</tr>
<tr>
<td>Institutional + Inter- + Intra-organizational level</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>

**TABLE 2.**
Studies in the sample, categorized after stages in the standardization process.

<table>
<thead>
<tr>
<th>Stage in the Process</th>
<th>No. of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence of standards</td>
<td>16</td>
</tr>
<tr>
<td>Implementation of standards</td>
<td>9</td>
</tr>
<tr>
<td>Effects of standards</td>
<td>11</td>
</tr>
<tr>
<td>Emergence + Implementation of standards</td>
<td>12</td>
</tr>
<tr>
<td>Emergence + Effects of standards</td>
<td>9</td>
</tr>
<tr>
<td>Implementation + Effects of standards</td>
<td>8</td>
</tr>
<tr>
<td>Emergence + Implementation + Effects of standards</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>
### TABLE 3.
Theoretical lenses applied in papers

<table>
<thead>
<tr>
<th>Institutional theory-related</th>
<th>Governance-related</th>
<th>Industrial organization</th>
<th>Strategic choice-related</th>
<th>Organizational/Behavioral theories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional theory</td>
<td>Market governance</td>
<td>Transaction Cost</td>
<td>RBV</td>
<td>Organizational theory</td>
</tr>
<tr>
<td>Neo-institutional theory</td>
<td>Price regulation</td>
<td>Cost</td>
<td>Strategic response</td>
<td></td>
</tr>
<tr>
<td>Negotiated order theory</td>
<td>Market entry regulation</td>
<td>Network externalities</td>
<td>Strategic fit</td>
<td>Behavioral theory</td>
</tr>
<tr>
<td>Socio-culture</td>
<td>Committee based stand/tion</td>
<td>Network evolution</td>
<td>Game theory</td>
<td>Bounded rationality</td>
</tr>
<tr>
<td>Social network</td>
<td>Socio-technology</td>
<td>Industry platform</td>
<td></td>
<td>Opportunism</td>
</tr>
<tr>
<td></td>
<td>Industry coordination</td>
<td>Industry life cycle</td>
<td></td>
<td>Path dependency</td>
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<tr>
<td></td>
<td>Marked competition</td>
<td></td>
<td></td>
<td>National standards “theory”</td>
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<td></td>
<td>Competition policy</td>
<td></td>
<td></td>
<td>DPS-theory</td>
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### TABLE 4.
Theoretical domains/explanations applied in papers – categorized after level of analysis and ordered after frequency of applicability in studies research

<table>
<thead>
<tr>
<th>Institutional level</th>
<th>Inter-organizational level</th>
<th>Intra-organizational level</th>
</tr>
</thead>
<tbody>
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<td>Institutional theory</td>
<td>Organization theory</td>
<td>Organization theory</td>
</tr>
<tr>
<td>Governance-related theory</td>
<td>Industrial organization</td>
<td>Governance-related theory</td>
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<td>Organization theory</td>
<td>Governance-related theory</td>
<td>Institutional theory</td>
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<tr>
<td>Industrial organization</td>
<td>Institutional theory</td>
<td>Strategic choice-related</td>
</tr>
</tbody>
</table>

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### TABLE 5.
Theoretical domains/explanations applied in papers – categorized after focus in the standardization process and ordered after frequency of applicability in studies research

<table>
<thead>
<tr>
<th>Emergence of standards</th>
<th>Implementation of standards</th>
<th>Effects of standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization theory /Behavioral theory</td>
<td>Organization theory /Behavioral theory</td>
<td>Industrial organization /Behavioral theory</td>
</tr>
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<td>Institutional theory</td>
<td>Organization theory</td>
</tr>
<tr>
<td>Governance-related theory</td>
<td>Governance-related theory</td>
<td>Institutional theory</td>
</tr>
<tr>
<td>Industrial organization</td>
<td>Industrial organization</td>
<td>Governance-related theory</td>
</tr>
</tbody>
</table>

### TABLE 6.
Research methods used in empirical studies - categorized after level of analysis (note that a study can be included in more than one category)

<table>
<thead>
<tr>
<th></th>
<th>Institutional level</th>
<th>Inter-organizational level</th>
<th>Intra-organizational level</th>
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</thead>
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<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Case study</td>
<td>5</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Interview</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Simulation</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Survey</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

### TABLE 7.
Research methods used in empirical studies - categorized after focus in the standardization process (note that a study can be included in more than one category)

<table>
<thead>
<tr>
<th></th>
<th>Emergence of standards</th>
<th>Implementation of standards</th>
<th>Effects of standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archival data(^2)</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Case study</td>
<td>14</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Interview</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Simulation</td>
<td>3</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Survey</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^1\) Case studies not included.
\(^2\) Case studies not included.
### TABLE 8.
Five most common definitions of standards ordered after frequency (words used when describing standards) – categorized after level of analysis

<table>
<thead>
<tr>
<th>Institutional level</th>
<th>Inter-organizational level</th>
<th>Intra-organizational level</th>
</tr>
</thead>
<tbody>
<tr>
<td>codified specifications</td>
<td>network effects</td>
<td>experience</td>
</tr>
<tr>
<td>SSOs</td>
<td>coordination</td>
<td>interoperability</td>
</tr>
<tr>
<td>harmonization</td>
<td>consensus</td>
<td>processes</td>
</tr>
<tr>
<td>de jure/de facto</td>
<td>formal</td>
<td>quality</td>
</tr>
<tr>
<td>regulation</td>
<td>industry consortia</td>
<td>routines</td>
</tr>
</tbody>
</table>

### TABLE 9.
Five most common definitions of standardization ordered after frequency (words used when describing standardization) – categorized after focus in the standardization process

<table>
<thead>
<tr>
<th>Emergence of standards</th>
<th>Implementation of standards</th>
<th>Effects of standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>governance</td>
<td>agreement</td>
<td>transaction costs reduction</td>
</tr>
<tr>
<td>regulation</td>
<td>dominant designs</td>
<td>economies of scale</td>
</tr>
<tr>
<td>compliance</td>
<td>guidelines</td>
<td>negotiation process</td>
</tr>
<tr>
<td>coordination</td>
<td>quality</td>
<td>communication</td>
</tr>
<tr>
<td>industry consortia</td>
<td>SSOs</td>
<td>conformity</td>
</tr>
</tbody>
</table>
### TABLE 10.
Papers in the sample addressing standardization and standards categorized after level of analysis

<table>
<thead>
<tr>
<th>Institutional level</th>
<th>Inter-organizational level</th>
<th>Intra-organizational level</th>
</tr>
</thead>
</table>

|----------------------------|----------------------------|----------------------------|----------------------------|
| Effects of standards | David and Greenstein (1990)  
| Greenstein (1992)  
| Davis (1997)  
| Jernigan and Moore (1997)  
| Feng (2003)  
| Christmann (2004)  
| Gerst and Jakobs (2005)  
| Tempel and Walgenbach (2007)  
| Perez-Aleman (2011)  
| Timmermans and Epstein (2010)  
| Blind (2011b)  
| Dokko et al. (2012)  
| Greenstein (1992)  
| Matutes and Regibeau (1996)  
| Schoder (2000)  
| Feng (2003)  
| Funk (2003)  
| Gerst (2003)  
| Christmann (2004)  
| Gerst and Jakobs (2005)  
| Den Butter et al. (2007)  
| Gallagher (2007)  
| Rysman and Simcoe (2008)  
| Tee and Gawer (2009)  
| Argyres and Bigelow (2010)  
| Blind et al. (2010)  
| Cusumano (2010)  
| Perez-Aleman (2011)  
| Manning et al. (2011)  
| Berger et al. (2012)  
| Montiel et al. (2012)  
| Reinecke et al. (2012)  
| David and Greenstein (1990)  
| Foss (1996)  
| Casile and Davis-Blake (2002)  
| Funk (2003)  
| Gilson et al. (2005)  
| Katsikeas et al. (2006)  
| Newbury and Yakova (2005)  
| Den Butter et al. (2007)  
| Tempel and Walgenbach (2007)  
| Tee and Gawer (2009)  
| Blind et al. (2010)  
| Perez-Aleman (2011)  
| Botzem and Dobusch (2012)  
| Brunsson et al. (2012)  
| van den Ende et al. (2012) |
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formation and diffusion of transnational standards: *Organization Studies*, v. 33, p. 737-
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