
Factors Affecting De Jure Standards' Adoption by Dutch High-Tech Start-Ups

An exploratory, comparative case study into the factors affecting de jure standards' adoption by Dutch high-tech start-ups and the potential influencing thereof by the Dutch standards organization.

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Executive Summary

The effects of standardization on entrepreneurship are a research field for which a lot still needs to be done. In particular, there is little research into the adoption of de jure standards by entrepreneurs. These standards are the product of committee-based standardization, which is when committees consisting of stakeholders that are related to the respective topic are coordinated by formal standards organizations to come to a consensus and formalize a standard. De jure standards are applied by for example governments to assist companies in complying with regulations but are not necessarily compulsory themselves. The factors affecting the adoption of these standards by high-tech entrepreneurs and the effects that they have are a relevant topic for further research. Thus, the research objective of this thesis is to investigate which factors affect the de jure standards adoption by high-tech start-ups, and within the scope of the Netherlands. In addition to this, the thesis also aims to discover if the factors effecting de jure standards adoption are possible to influence by the Dutch standards organization (the NEN), and if so, how.

This thesis is setup as a theory-building, explorative case study consisting of 3 rounds of data collection. The first is a literature review into the studies of de jure standards adoption and the determination of which major recurring theories and frameworks are applied in these studies. Three major recurring applied theories were found, the diffusion of innovation, neo-institutionalism and the network economics approach applied in the TOE framework. A list of potential factors was formulated from the factors applied in the relevant studies, using the aforementioned theories and frameworks. The literature-backed list consists of: (1) Perceived relative advantage, (2) Perceived compatibility, (3) Perceived complexity, (4) Observability, (5) Competitive pressure, (6) Environmental uncertainty, (7) Mimetic pressure, (8) Coercive pressure, (9) External support, (10) Normative pressure, (11) Management support, (12) Centralization, (13) Formalization, and (14) Organizational size.

This list of factors was used as a basis for the 2nd step of data collection in this case study: the 1st round of semi-structured interviews. This 1st round of interviews consisted of interviews with 6 cases: 5 Dutch high-tech start-ups and a NEN official. The interview transcripts were codified and analyzed to determine which factors the start-ups identify, and which effect they mention the factor has. Factors were also mentioned that were not included in the literature-backed list. These were axially (thematically) analyzed to formulate new propositional factors. The transcripts were then analyzed again to determine if the new propositional factors were mentioned by the others as well, and which effect they mention. This data is used to build upon the literature-backed list of factors. The result is thus a list of factors consisting of literature-backed factors that were identified and the new propositional factors. In other words, a list of factors that the high-tech start-ups and the NEN official identify. This list consists of: (1) Perceived relative advantage, (2) Perceived compatibility, (3) Perceived complexity, (4) Environmental uncertainty, (5) Mimetic pressure, (6) Coercive pressure, (7) External support, (8) Normative pressure, (9) Management support, (10) Centralization, (11) Formalization, (12) Organizational size, (13) Awareness/prior knowledge, (14) Processual characteristics, (15) Trust in evolution of standard and (16) Costs. The effects of the standards were also collected, interpreted and discussed. A significant outcome is that there is a distinction between the adoption of a single standard and the adoption of a combination of

standards and that this can be seen as a factor, which has a moderating effect on certain other factors.

The last round of data collection consisted of a 2nd round of semi-structured interviews with 2 cases: (1) a NEN official and (2) two standards organization experts. These interviews were to determine which factors the cases identify as possible to influence and how. The results of this are that the cases identify the factors of coercive pressure, awareness/prior knowledge, trust in evolution of standard and costs as possible to influence.

This research is one of the first studying the factors affecting de jure standards adoption by high-tech start-ups. There are multiple points of contribution to theoretical literature: the aforementioned list of identified factors and their respective effects on de jure standards adoption, and the factors that were determined possible to influence.

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List of abbreviations

NEN	-	Stichting Koninklijk Nederlands Normalisatie Instituut
CEN-CENELEC	-	European Committee for Electrotechnical Standardization
ISO	-	International Organization for Standardization
DOI	-	Diffusion of Innovation
TOE	-	Technological-Organizational-Environmental
EU	-	European Union

1. Introduction

1.1 – Standardization: a background

Many studies have covered standardization. The USB format, gasoline, MP3 format, QWERTY, WiFi, ATM card sizes: these are just a few things that have been the result of standardization. As J. Farrell and G. Saloner put it, standardization is “an explicit or implicit agreement to do certain key things in a uniform way” (Farrell & Saloner, 1992).

The USB format would not be as useful as it is today if most (if not all) computers did not use the same exact input port, we would have to purchase different connectors for every different brand (or model) of computer and accessory. The same is the case for gasoline. How "for granted" do we take it that the ignitory liquid that we fill our cars up with is the same composition at every gas station around the globe? Herein lies the intent of standardization in its most basic form, to enable a standard is to agree upon a certain degree that is in the best interest of all parties, concerning degrees in the aforementioned categories of standards.

Standards, unlike legislature, are not necessarily binding. However, they are generally accepted as they are agreed upon and enabled by actors (mainly firms) in the respective market. To elaborate further on the previous example, companies in the personal computer market agreed upon multiple standards to enable compatibility, strengthening their collective market positions whilst being competitors. Petrol and automotive companies did the same regarding, respectively, the composition of gasoline and the coinciding engine variants.

Standardization formation can take place in 3 different ways: committee-based, government-based or market-based standardization. These all have different mechanisms of coordination, committee-based standardization results in “de jure” standards for example, the main focus of this research. Committee-based standardization is a form of standardization that is organized by a formal standardization organization, wherein a group of firms, relevant to the subject of standardization, convene to agree upon a standard for e.g. the quality of the product in question. These can be created at multiple levels: In the Netherlands there is the Stichting Koninklijk Nederlands Normalisatie Instituut (NEN) at the national level, the European Committee for Electrotechnical Standardization (CEN CENELEC) works at a European level and the International Organization for Standardization (ISO) works at an international level. These are formal standardization organizations that coordinate committee-based standardization in their respective scopes.

In journal articles dating back to 1985, negative aspects of standardization with respect to innovation and entrepreneurship were (already) identified. As J. Farrell and G. Saloner state, “But standardization has its costs. First, it may retard innovation” (Farrell & Saloner, 1992). Standardization still needs a lot of research to be conducted as it is still an area with a very complex dynamic (Wiegmann et al., 2017). The dynamic between standardization and innovation is the topic of multiple studies and theories. Some state that standardization enables innovation while others pose that it could slow down innovation (Viardot et al., 2016). Multiple studies have been conducted as well into the adoption of de jure standards such as (Guler et al., 2002) and (Hashem & Tann, 2007), but no studies specifically focus on high-tech start-ups and their standards adoption factors. High-tech start-ups having innovative products, could experience the severe negative effects debated about in the innovation

literature. On the other hand, the adoption of *de jure* standards could help them access new markets (Shapiro & Varian, 1999).

1.2 – Knowledge gap: Factors concerning *de jure* standards adoption amongst high-tech entrepreneurs

A present-day overview of factors affecting the adoption of *de jure*, or committee-based, standards by high-tech start-ups is lacking. What are the reasons a high-tech start-up would adopt a standard for their business or their product? What are factors that influence the decision to adopt a standard?

There are multiple theories that have been applied in *de jure* standards adoption studies such as the neo-institutional theory (Meyer & Rowan, 1977; Dimaggio & Powell, 1983), the economic theory on standards adoption (Katz & Shapiro, 1986) and the diffusion of innovation theory (Rogers, 1962). However, these theories are not formulated or researched specifically regarding *de jure* standards adoption for high-tech entrepreneurs.

1.3 – Research Objective & Questions

The research objective is formulated as follows: *The objective of this thesis is to contribute to the development of theory regarding de jure standards adoption by exploratively investigating the de jure standards adoption of Dutch high-tech start-ups, identifying potential relevant factors that affected it, determining potential relationships between the factors and de jure standards adoption amongst Dutch high-tech start-ups and determining if and how Dutch standards organizations can influence the factors.*

The focus of this research is a summation of the previous introduction, namely, research into factors influencing the adoption of *de jure* standards by Dutch high-tech start-ups. The thesis strives to explore the factors of *de jure* standards adoption with the scope set on high-tech start-ups in the Netherlands. Therefore, the main research question is as follows:

Main Research Question: *What factors affect de jure standards adoption amongst high-tech start-ups in the Netherlands and are these factors possible to influence by the Dutch standards organization?*

The aim is to explore the factors from not only the side of the entrepreneur but from the side of the Dutch standards organization as well. Next to this, the question arises if the factors can be influenced by the Dutch standards organization, and if so, how this is possible. Therefore, the following sub. research questions have been formulated:

Sub. Research Question #1: *What factors affect de jure standards adoption by Dutch high-tech start-ups, according to scientific literature?*

Sub. Research Question #2: *What factors that affect de jure standards adoption by Dutch high-tech start-ups do Dutch high-tech start-ups themselves identify?*

Sub. Research Question #3: *What factors that affect de jure standards adoption by Dutch high-tech start-ups do Dutch standards organization experts identify?*

Sub. Research Question #4: *Is it possible for the Dutch standards organization to influence the factors affecting de jure standards adoption by Dutch high-tech start-ups and, if so, how?*

1.4 – Relevance to Science and Society

1.4.1 – Theoretical contribution

This thesis research aims to provide insights into factors affecting the adoption of *de jure* standards amongst high-tech entrepreneurs. This is because the theoretical background amongst scientific literature does not cover *de jure* standards adoption specifically by high-tech start-ups, and also does not cover the potential influence on these factors by standards organizations. In addition to this, this research aims to provide a foundation for future research into this subject. A review of this contribution is given in section 5.4.1.

1.4.2 – Practical implications

This research report aims to improve the understanding of the adoption of *de jure* standards by high-tech start-ups. This improved understanding could provide insights for entrepreneurs, policy makers as well as formal standardization organizations.

Firstly, the aim is to enlighten entrepreneurs in the factors of standards adoption concerning *de jure* standards. As there is little research into the adoption of *de jure* standards specifically by high-tech start-ups, this research could reduce or eliminate knowledge gaps for entrepreneurs, resulting in reducing insecurity amongst high-tech entrepreneurs on their own standards adoption. By identifying the relevant factors, high-tech start-ups can make more informed decisions on which standard to adopt.

The second aim, linking to the previous remark, is to aid in the understanding of the entrepreneur side of things by the formal standardization organizations. By generating insights based on entrepreneur experience within the scope of high-tech start-ups in the Netherlands, the research shares experiences from interviewed high-tech start-ups that could build upon knowledge they already have, therefore improving the quality of their knowledge base. This with the aim of possibly improving the standardization (or adoption) process where needed, if needed.

Third and lastly, this research aims to build upon the knowledge base of policymakers, greatening their understanding of this specific scope of stakeholder, possibly improving the quality of the decision-making process.

1.5 - Outline of thesis

Following the introduction, Chapter 2 covers the theoretical background of this research, followed by the research methodology in Chapter 3. The results are presented in Chapter 4, followed by the interpretation of the results and discussion in Chapter 5. After this, in Chapter 6, conclusions on this research are addressed and finally, in Chapter 7, the research is reflected upon.

2. Theory

This chapter addresses the theoretical background of this research. From scientific literature, three major recurring theories that are applied in ISO standards adoption studies are covered. It follows the literature review search as described in section 3.1. From the discovered studies, recurring major theories and frameworks were identified and chosen to proceed with in the research. This section will expand on the literature concerning these theories and frameworks.

2.1 – Initial literature review

An initial literature review was conducted, aimed at investigating relevant de jure standards adoption studies and the theories they apply, this is described in section 3.1. The recurring major theories and frameworks concerning ISO standards adoption were collected and compared. From these theories, a propositional list of potentially relevant standards affecting de jure standards adoption by high-tech start-ups was formulated, which was used in the following steps of this research. The applied theories and frameworks consist of the DOI, NI theories and translated TOE-framework by (Hashem & Tann, 2007). In this chapter, an initial background is given to standards adoption and, from there, the background is addressed of the relevant theories and frameworks and the relevant studies described.

2.2 – Models & theories of adoption

In the journal article “A model of Internet standards adoption: the case of IPv6” (Hovav et al., 2004), a study into the adoption of the IPv6 internet standard, Anat Hovav formulates a new model for internet standards adoption through the combination of DOI (Diffusion of Innovation) and economics of adoption literature (Hovav et al., 2004). Herein, Hovav states that the competition between standards is similar to that between innovations and therefore DOI is applicable to study their diffusion (Arthur, 1988; Hovav et al., 2004). Therefore, the first topic presented is that of the DOI.

2.2.1 – DOI – Diffusion of Innovation

The Diffusion of Innovation aspect of the article takes factors into account put forth by (Rogers, 1962) and elaborated further on by Tornatzky & Klein (Tornatzky & Klein, 1982) and Fichman & Kemerer (Fichman & Kemerer, 1993).

In his theory, Everett Rogers identified five innovation attributes from his review of diffusion studies, as cited by (Fichman & Kemerer, 1993). These are: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability and (5) observability (Rogers, 1962). Explanations concerning these 5 aspects are given in Table 1.

These five attributes concern the innovation itself, i.e. an internal view. However, even as the attributes are focused on the innovation’s characteristics, the DOI perspective on diffusion considers communication as the main aspect in the process. How an adopter learns about the innovation and when are important aspects to whether adoption will occur (Fichman & Kemerer, 1993).

The initial theory was focused on individuals' innovation adoption but “Van de Ven and others have argued that innovation attributes also play an important role in adoptions by organizations” (Fichman & Kemerer, 1993). Therefore, these attributes are relevant to the standards' adoption of individual firms.

Factor	Explanation
1. Relative advantage	The degree that an innovation is perceived as better than its predecessor. (Rogers, 1962, 1995; Hashem & Tann, 2007)
2. Compatibility	The degree that an innovation fits with company values and needs. (Rogers, 1962, 1995; Hashem & Tann, 2007)
3. Complexity	The perceived difficulty of use of an innovation. (Rogers, 1962, 1995; Hashem & Tann, 2007)
4. Trialability	The degree of experimentation can be done before adoption of the innovation. (Rogers, 1962, 1995)
5. Observability	The degree of visibility of others' use of the innovation. (Rogers, 1962, 1995; Hashem & Tann, 2007)

Table 1: DOI factors and their descriptions

2.2.2 – Network Economics

As Hovav explains, when considering factors affecting standards adoption, the DOI perspective cannot be considered by itself, but the network economics aspect must be taken into account as well. The community aspect of a firm affecting its decision to adopt, being influenced by other actors in the community also needs to be taken into account (Hovav et al., 2004).

The “economic perspective” of the article considers factors put forth by, a.o., Farrell & Saloner (Farrell & Saloner, 1985), Katz & Shapiro (Katz & Shapiro, 1986) and Arthur (Arthur, 1988). This perspective, in contrast to the DOI perspective, focuses on the external influences on innovation adoption. In the article by Katz & Shapiro (Katz & Shapiro, 1986), concerning compatibility standards, they formulate an oligopoly-like model wherein they identify that the perceived value of a product by consumers is higher when compatible with other consumer products, this they call “network externalities” (Katz & Shapiro, 1986). In a later article by Katz & Shapiro, they find, amongst other things, that the pattern of adoption heavily depends on whether technologies undergo sponsorship (Katz & Shapiro, 1986). In its absence, superior technology has a strategic advantage and will probably dominate the market, whereas if there is speak of sponsorship, that technology has the strategic advantage and could be adopted, even if inferior (Katz & Shapiro, 1986).

The journal article by Farrell & Saloner (Farrell & Saloner, 1985), focusing on compatibility standards as well, examines if an industry can become “trapped” with an inferior standard through the supposed benefits of standardization (Farrell & Saloner, 1985).

Arthur (Arthur, 1988), in his paper, explores a model of innovation adoption to discover where the innovation improves when its adoption rate increases (Arthur, 1988). The paper identifies certain aspects that adds to previously identified factors identified by Katz & Shapiro and Farrell & Saloner.

The factors from the economic perspective, treated by the five respective authors, are: (1) Network externalities, (2) Related technologies, (3) Installed base, (4) Communications channels and general industry knowledge, and (5) sponsorship (Hovav et al., 2004). Explanations concerning these attributes are given in Table 2.

Factor	Explanation
1. Network externalities	The adoption depends on the number of those who have already adopted and will adopt. (Farrell & Saloner, 1985; Katz & Shapiro, 1986; Hovav et al., 2004)
2. Related technologies	The degree to which there are other compatible technologies. (Arthur, 1988; Hovav et al., 2004)
3. Installed base	Installed base generates so-called drag, as it is already invested money and resources. (Farrell & Saloner, 1986; Hovav et al., 2004)
4. Communications channels	Channels in which information about the innovation can be communicated. (Farrell & Saloner, 1985; 1987; Arthur, 1988; Hovav et al., 2004)
5. Sponsorship	An entity that provides resources towards the adoption of the innovation. (Katz & Shapiro, 1986; Hovav et al., 2004)

Table 2: Network economics factors and their descriptions

These factors are not directly used in the list of potential factors but they are of direct influence on the TOE framework by Tornatzky & Fleischer used in (Hashem & Tann, 2007).

2.2.3 – Neo-institutional theory

The network economics theory addresses the external environment in standards' adoption to a certain degree. It focuses more on externalities enacted on the firm instead of firms amongst each other. Another dimension to add to the mix, therefore, is the interrelatedness between firms and their effect on each other therein. This correlates closely with the neo-institutional theory formulated first by Meyer & Rowan (Meyer & Rowan, 1977) and elaborated further on by Dimaggio & Powell (Dimaggio & Powell, 1983). The theory concerns the effect organizations have on each other in their respective environments. In their paper, Dimaggio & Powell formulate that rational actors change their organizations to increasingly similar states, which they call "homogenization" (Dimaggio & Powell, 1983). According to them, isomorphism best captures the process of homogenization (Dimaggio & Powell, 1983). It is a constraining process by which a single unit will tend to want to resemble others in the same environmental conditions (Dimaggio & Powell, 1983).

They put forth that there are two types of isomorphism: institutional and competitive. Competitive isomorphism is most relevant where the competition is open and free (Dimaggio & Powell, 1983) but it does not represent an accurate representation of the modern dynamic of organizations amongst each other. To solidify this, the concept of institutional isomorphism comes into play, where the focus is more on the foundation and accommodation of the organization with the outside environment (Dimaggio & Powell, 1983). They identify three different types of pressures that instigate this institutional isomorphism: (1) coercive, (2) mimetic and (3) normative pressures. These pressures are explained in the following table.

Factor	Explanation
1. Coercive pressure	Coercive pressures are forceful pressures exerted by outside actors on the organization. (Dimaggio & Powell, 1983)
2. Mimetic pressure	Mimetic pressures are pressures of imitation in for example cases of uncertainty. (Dimaggio & Powell, 1983)
3. Normative pressure	Normative pressures are pressures of ideology or legitimization, adopting innovation due to norms and values of the company etc. (Dimaggio & Powell, 1983)

Table 3: Neo-institutional factors and their descriptions

In summation, these three theories will be the core theoretical basis for the formulation of factors affecting standards adoption in general. Building upon the background gathered from these three theories, the TOE framework was consulted and the study by (Hashem & Tann,

2007). The TOE framework partially addresses the DOI theory as well as environmental factors, linking to the network economics approach previously mentioned. The study by (Hashem & Tann, 2007) was consulted as it consists of three categories, of which two are derived from the previously mentioned theories. The first, "perceived characteristics of the standard" was derived from the DOI theory. The second, "Characteristics of the external environment", links to the environmental factors of the TOE framework as well as the network economics approach.

2.2.4 – Technological – Organization – Environment (TOE) framework

In this study, Tornatzky & Fleischer developed a framework of three elements that affect innovation adoption by organisations (Hashem & Tann, 2007): the technological, organizational and environmental contexts. They put forth that it is important to pay careful attention to both the characteristics of the adopter and the context of the situation (Hashem & Tann, 2007).

This framework partially consisted of factors from the DOI theory, elaborating further on previous research in (Tornatzky & Klein, 1982), namely the technological context, and formed the basis for the subsequent study of (Hashem & Tann, 2007).

2.2.5 – Hashem & Tann (Hashem & Tann, 2007)

Hashem & Tann built upon the research of Tornatzky & Fleischer by aiming to integrate the stages of the adoption process, formulated by Rogers (Rogers, 1995; Hashem & Tann, 2007).

The model, consisting of five stages of innovation adoption, is the basis for most empirical studies concerning themselves with the innovation process (Hashem & Tann, 2007).

This study thus builds upon the TOE framework of Tornatzky & Fleischer by implementing the innovation adoption model and generates a coherent list of factors influencing ISO 9000 standards' adoption, as well split into three categories. They utilized the list and model to analyze the adoption of ISO series 9000 standards amongst Egyptian manufacturers. The factors can be seen in the following figure.

	Factor	Explanation
Perceived characteristics of standard		
	1. Relative advantage	Perceived potential benefits received from adopting the standard, relative to the prior situation, such as customer satisfaction, increases in sales and/or profit, access to new markets, or increased competitive advantage. (Rogers, 1962, 1995; Hashem & Tann, 2007)
	2. Compatibility	The perceived fit of the standard with existing company values and needs. (Rogers, 1962, 1995; Hashem & Tann, 2007)
	3. Complexity	The perceived difficulty of the understanding and utilization of the standard. (Rogers, 1962, 1995; Hashem & Tann, 2007)
	4. Observability	The observing of the adoption of the standard of others, being able to assess the standard before adopting it themselves. (Rogers, 1962, 1995; Hashem & Tann, 2007)
Characteristics of external environment		
	5. Competitive pressure	Pressure amongst competitors to gain competitive advantage by means of adopting the standard. (Hashem & Tann, 2007)

	6. Environmental uncertainty	Uncertainty concerning the external environment of the high-tech start-up such as the future state of markets, regulations, etc. (Hashem & Tann, 2007)
	7. External pressure	Pressure from external parties to adopt a standard (Hashem & Tann, 2007)
	8. External support	Support from thirds parties in adopting the standard, for example by means of funds or resources. (Hashem & Tann, 2007)
Characteristics of Organization		
	9. Management support	Support from within the companies' management for the adoption of the standard. (Hashem & Tann, 2007)
	10. Centralization	The degree of concentration of power within the company in a small group of individuals, such as the executive board. (Rogers, 1995; Hashem & Tann, 2007)
	11. Formalization	The degree of designation and application of protocol and procedure within a company. (Rogers, 1995; Hashem & Tann, 2007)
	12. Organizational size	The size of the organization, concerning not only numbers of employees but also i.e. number and concentration of establishments. (Hashem & Tann, 2007)

Table 4: Factors in (Hashem & Tann, 2007) and their descriptions

2.2.6 – Overview of factors

In section 3.1, an overview can be seen of proposed factors affecting de jure standards' adoption in general. The decision was made to include the DOI theory factors, the environmental and organizational characteristics from the study by Hashem & Tann, and the NI, or neo-institutional theory's pressures.

The economic perspective with network externalities by (Katz & Shapiro, 1986; Farrell & Saloner, 1985) were translated into the TOE framework of (Tornatzky & Fleischer, 1990) and subsequently also used in the study of (Hashem & Tann, 2007). Therefore, the economic perspective with network externalities, translated into the TOE framework and reformulated by Hashem & Tann were chosen.

3. Methodology

In this chapter, the research methodology of this exploratory, comparative, theory-building case study is addressed. This concerns the research methods for the collection and analysis of data in order to fulfill the research objective by answering the respective (sub-)research questions. This comparative case study is designed as a theory-building comparative case study as defined in (Dul & Hak, 2008). The sources of data are the two rounds of conducted interviews (primary data) and relevant standards adoption studies in scientific literature (secondary data). The following sections address the respective steps of the research methodology in order.

3.1 – Literature review

The literature review was conducted to provide a theoretical foundation for the rest of this research. The end product of the literature review is a list of potentially relevant factors affecting de jure standards adoption, gathered from recurring theories being applied in multiple studies of de jure standards adoption. The literature review consists of three steps. Firstly, de jure (ISO) standards adoption studies were consulted to identify recurring theories being applied in these studies, until the list of recurring theories became saturated. Second, the recurring theories and their application in the respective de jure standards adoption studies were examined to determine potentially relevant factors affecting de jure standards adoption. Thirdly, the potentially relevant factors were combined where similar, left out where potentially irrelevant (given the context of the respective studies) and finally listed together to form a literature-based list of factors affecting de jure standards adoption, this process is described in the following sub-sections.

3.1.1 – Search for de jure standards adoption studies

The search for specifically de jure standards adoption studies focusing on high-tech start-ups proved unfruitful. Therefore, the decision was made to base the search on ISO standards adoption studies in general, as ISO standards are committee-based standards (i.e. de jure) and there are many ISO adoption studies. Next purely ISO adoption studies, a systematic review of ISO adoption studies was also consulted, as it covers multiple studies and creates an overview. It was deemed that this method of searching for relevant recurring themes in as many ISO adoption studies as possible (until the list was deemed saturated) was most efficient. The found studies are listed below in Table 5, with their specific standard, target group and applied theory.

	Study	Standard	Target group	Applied theory/framework
1.	Hashem & Tann (2007)	ISO 9000	Egyptian manufacturing companies	TOE; DOI
2.	Boiral et al. (2018)	ISO 14001	<i>Systematic review</i>	<i>No specific theory or framework but list of factors</i>
3.	Kasperaviciute-Cerniauskiene (2016)	ISO 9001	Lithuanian higher-education institutions	DOI
4.	Heras-Saizarbitoria & Boiral (2015)	ISO 9000	SMEs	NI; “symbolic adoption”
5.	Bansal & Hunter (2003)	ISO 14001	US firms that were ISO 14001 certified	<i>No specific theory or framework but list of factors</i>
6.	Prajogo et al. (2012)	ISO 14001	Australian enterprises	NI; Natural Resource-based view
7.	Georgiev & Georgiev (2015)	ISO 9000	Bulgarian enterprises	Dual model (internal/external motivations perspective)
8.	Papadimitriou & Westerheijden (2010)	ISO 9000	Greek universities	NI
9.	Castka & Balzarova (2008)	ISO 26000	Global diffusion	DOI, NI
10.	Chan & Wong (2006)	ISO 14001	Hotel industry	<i>No specific theory or framework but list of factors</i>
11.	Delmas & Montes-Sancho (2011)	ISO 14001	National institutions	NI
12.	Guler et al. (2002)	ISO 9000	Cross-national diffusion	NI

Table 5: ISO standards adoption studies, their resp. standards, target groups and applied theories/frameworks

The order in which the studies are listed is the order in which they were found. The search continued until the list of recurring applied theories was deemed saturated. This definitive list consists of 1 systematic review and 11 studies of adoption of ISO standards. It should be noted that ISO 9000 and 9001 are quality standards, ISO 14001 is an environmental management standard and ISO 26000 a process standard, but the scope of this research does not discriminate in type of standard and therefore none of the studies thereof will be excluded.

3.1.2 – Combination and subsequent formation of list of potential factors

The aim here is to find the main recurring theories and add/combine relevant factors from other relevant studies in the list. From the listed theories in Table 5, it can be seen that DOI, or the diffusion of innovation theory by Rogers (Rogers, 1962), and the NI, or neo-institutionalism, formulated by DiMaggio & Powell (DiMaggio & Powell, 1983) are recurring theories used in the studies. These two theories therefore became the 1st iteration of chosen factors for the theoretical background. As the factors of the DOI concern innovation adoption, these were translated to standards adoption following the descriptions used in (Hashem & Tann, 2007). Trialability was left out as it is not possible to test quality standards (Hashem & Tann, 2007). In the 2nd iteration, factors from (Georgiev & Georgiev, 2015) were combined with the chosen list. Descriptions for the factors can be found in section 2.2.5. The right

column shows where the factors fit in the 1st iteration of chosen factors. This can be seen below in Table 6.

<i>1st Iteration chosen factors</i>	
Perceived advantage of de jure standard	
1. Perceived relative advantage	
2. Perceived compatability	
3. Perceived complexity	
4. Perceived observability	
NI (Dimaggio & Powell, 1983)	
1. Coercive pressures	
2. Mimetic pressures	
3. Normative pressures	

<i>Factors in (Georgiev & Georgiev, 2015)</i>	
Internal	Fit in 1st iteration
1. Process improvement	-> Already included in "Perceived relative advantage"
2. Product quality improvement	-> Already included in "Perceived relative advantage"
External	Fit in 1st iteration
1. Customer pressure	-> Already included in "Coercive pressures"
2. Enhanced company image	-> Already included in "Normative pressures"

Table 6: 1st iteration combination of factors

The factors “Process improvement” and “Product quality improvement” from (Georgiev & Georgiev, 2015) fall into the description of “Perceived relative advantage”, the factor “Customer pressure” falls into that of “Coercive pressures” and the factor “Enhanced company image” into that of “Normative pressures”. With this the 2nd iteration of chosen factors was created, which was then combined in the same way with the factors from (Hashem & Tann, 2007). This combination can be seen below in Table 7.

<i>2nd Iteration chosen factors</i>	
Perceived advantage of de jure standard	
1. Perceived relative advantage	
2. Perceived compatability	
3. Perceived complexity	
4. Perceived observability	
NI (Dimaggio & Powell, 1983)	
1. Coercive pressures	
2. Mimetic pressures	
3. Normative pressures	

<i>Factors in (Hashem & Tann, 2007)</i>	
Perceived advantage of ISO standard	Fit in 2nd iteration
1. Perceived relative advantage	-> Already included
2. Perceived compatability	-> Already included
3. Perceived complexity	-> Already included
4. Perceived observability	-> Already included
Characteristics of the External Environment	Fit in 2nd iteration
5. Competitive pressure	-> Added
6. Environmental uncertainty	-> Added*
7. External pressure	-> Removed
8. External support	-> Added
Organisational characteristics	Fit in 2nd iteration
9. Management support	-> Added
10. Centralisation	-> Added
11. Formalisation	-> Added
12. Organizational size	-> Added

Table 7: 2nd iteration combination of factors

The “Perceived relative advantage of ISO standard” category factors are already part of the model, the factor “External pressure” falls into the description of “Coercive pressures” and the other factors were all added. It should be noted that mimetic pressures are described to originate partly from environmental uncertainty (Dimaggio & Powell, 1983) but are not the only consequence thereof. Therefore, “Environmental uncertainty” was added as well. The NI factors are all external pressures enacted upon the adopter and therefore they were added to the added category from (Hashem & Tann, 2007), “Characteristics of the External Environment”. This resulted in the 3rd iteration, which can be seen in Table 8.

The 3rd iteration then underwent the same process but with the factors from the systematic review of (Boiral et al., 2018). This was chosen as it is a review of 94 papers and therefore adds to the relevance of the factors combined in this process.

3rd Iteration chosen factors	
Perceived advantage of de jure standard	
1. Perceived relative advantage	
2. Perceived compatability	
3. Perceived complexity	
4. Perceived observability	
Characteristics of the External Environment	
5. Competitive pressure	
6. Environmental uncertainty	
7. Mimetic pressures (NI)	
8. Coercive pressures (NI)	
9. External support	
10. Normative pressures (NI)	
Organizational characteristics	
11. Management support	
12. Centralization	
13. Formalization	
14. Organizational size	

Factors in (Boiral et al., 2017)	
Drawbacks	
1. Costs and lack of resources	-> Removed*
2. Bureaucracy and excessive documentation	-> Removed
3. Superficial adoption	-> Already included in "Normative pressures"
4. Time constraints	-> Removed*
5. Resistance to change	-> Removed
6. Lack of internal capabilities	-> Already included in "Perceived complexity"
7. Expertise of registrars and consultants	-> Already included in "External support"
Contingent factors	
8. Managers' support and commitment	-> Already included in "Management support"
9. Employee involvement and empowerment	-> Removed
10. Intergration with existing practices	-> Already included in "Compatibility"
11. Internalization	-> Removed
12. Motivation for certification	-> Already included in NI pressures
Contextual factors	
13. Company size	-> Already included in "Organizational size"
14. Maturity of certification	-> Removed*
15. Early adoption	-> Already included in "Environmental uncertainty"

Table 8: 3rd iteration combination of factors

In the column on far right it is shown which factors fit into the descriptions of already included factors. The factors of “Bureaucracy and excessive documentation” and “Resistance to change” were removed as the context of the standard in the study, ISO 14001, is an environmental management standard, and these factors are deemed specific for that context and are not general factors which can be used. The factors “Employee involvement” and “Internalization” are also excluded as they concern larger corporation coordination issues, not relevant for start-ups. The factors “Costs and lack of resources”, “Time constraints” and “Maturity of certification” are also excluded as they are specific to the context of ISO 14001 as well, namely that the ISO 14001 is not necessarily a governmental requirement but are kept in a “potential reserve”, meaning that if factors are identified that coincide with these, they will be included, nonetheless. The factors were “translated” to standards terms according to the background given in Chapter 2. This concluded the combination and subsequent formation of the list of potential factors found in the literature, which can be found in section 4.1, Table 12. This description and relevant theories connected to each factor are given in Chapter 2.

3.2 – 1st round of semi-structured interviews – High-tech start-ups and NEN official

The next step in this research is the conduction of semi-structured exploratory interviews with Dutch high-tech start-ups and a Dutch standards organization expert to determine which factors they identify affecting the de jure standards adoption of Dutch high-tech start-ups, and the effect these factors had. There is no time limit on the interviews, they are concluded when the amount of data and context is deemed sufficient. The interviews are recorded, then transcribed and translated if necessary.

3.2.1 – Selection of candidates

Candidate selection was done by means of convenience sampling. The definition of “high-tech” according to the Cambridge Dictionary considers the use of the “most advanced and developed machines and methods”. In this research, the definition of high-tech start-ups refers to innovative start-ups with a product that requires considerable research and development

initiative before being able to enter the market. Over 50 high-tech start-ups were approached that are situated in the high-tech incubator YES!Delft, that are connected with the TU Delft and others via personal network. Of these, 5 start-ups responded as willing to participate in the study. Next to this, a NEN official was also interviewed to, as previously mentioned, provide an identification angle from the side of the Dutch standards organization. This NEN official coincides with the *expertise* criterium of (Shanteau et al, 2002), indicating that this is a relevant expert. The interviewees (cases) are listed with a description in Table 9.

Case	Role/position	Product
1.	Co-founder, CEO	Floating solar panel installations
2.	Co-founder, CTO	Consumer-based battery-wall solutions
3.	Co-founder, CEO	SaaS-enabled clean energy solutions market platform
4.	Co-founder, Consultant	Modular housing
5.	Co-founder, CTO	Industrial modular battery solutions
6.	Innovation, Education & New Business (3 yrs) and Senior Consultant at NEN (6 yrs.);	

Table 9: Interviewed cases 1st round of semi-structured interviews

3.2.2 – Questions

The questions are semi-structured in the fact that a couple of questions recur in the interviews. The first is to ask the start-up to introduce their company, providing information on their company and its foundation. Next, the interviewee is asked if they have experience with adopting de jure standards. If so, they are asked to share their experience with adopting it and their motivation to do so. In this way, the interviewee shares contextual data as well. Unstructured follow-up questions can be asked to the interviewee to elaborate further on certain aspects. In the case of the NEN official, this will not concern own standards adoption experience but the experiences of other high-tech start-ups that the NEN official has advised/come into contact with within a professional context. The list of literature-backed potential factors for standards adoption in 4.1 was not shown to the interviewees, aiming to prevent bias in the exploration of factors they identify/reflect on.

3.3 – 1st round of data analysis and interpretation

The transcriptions from the 1st round of semi-structured interviews are first codified to determine which factors the cases mention (implicitly and/or explicitly). Following this, the factors are cross-referenced with the list of potentially relevant factors retrieved from scientific literature, the list found in section 4.1. With this an overview is made of if they mention factors from the literature list and if the mentioned effect is positive or negative. Following this, factors that are mentioned that cannot be connected to factors in the literature list are gathered and axially coded (Dul & Hak, 2008) to determine if these other factors can be categorized to formulate potential “new” factors (the new propositions aspect of the building of theory). Afterwards the interviews are again analyzed to determine which of them mention the “new” factor and what its effect was (the relation between concepts aspect of theory-building). The results of this are then the answer to sub-research question 2 and 3 and will be further elaborated on and discussed in Chapter 5.

3.4 – 2nd round of semi-structured interviews – Standards organization experts

The 2nd round of semi-structured interviews is aimed at discovering which factors are identified by standards organization experts that could potentially be influenced, and if so, how. There is no time limit on these interviews as well, they are concluded when the amount of data and context is deemed sufficient. The interviews are recorded, then transcribed and translated if necessary.

3.4.1 – Selection of candidates

The same NEN official participated in this round of interviews as well as two other standards organization experts. The candidates were selected by means of convenience sampling as well. The 2nd expert was approached via personal network and identified and connected the 3rd expert to participate as well. The NEN official, as previously mentioned, fulfills the criterium of *expertise*, as formulated by (Shanteau et al, 2002). The 2nd and 3rd interviewee fulfill the criteria of *expertise* and *social acclamation* (Shanteau et al, 2002). Case 7 consists of two interviewees as they were committee colleagues for CEN/TC 278 and were therefore interviewed together. An overview of these candidates, their (previous) positions and years of experience are shown in Table 10.

Case	Organization	Context
7	ex. CEN	Previous chairman of CEN/TC 278 Intelligent transport systems;
7	ex. NEN; ex. CEN	Previous ISO committee manager ISO/TC 154 eBusiness (3 yrs.); Previous NEN Committeemanager standardization (10 yrs.); Previous CEN/CENELEC committeemanager CEN/TC 278 Intelligent transport systems;
8	NEN	Innovation, Education & New Business (3 yrs) and Senior Consultant at NEN (6 yrs.);

Table 10: Interviewed cases 2nd round of semi-structured interviews

3.4.2 – Questions

The interviewees in this round of interviews are asked about the de jure standards adoption process and the influencing of factors. The semi-structured aspect is that they are told the standards adoption experiences of the interviewed high-tech start-ups and asked to provide feedback on this. From there, unstructured follow-up questions are asked to elaborate on certain aspects or provide additional context.

3.5 – 2nd round of data analysis and interpretation

The transcriptions of the 2nd round of interviews, those with the standards organization experts, are codified, determining which factors they mention (implicitly and/or explicitly) as possible to influence and how they think this is possible. This will be discussed in section 5.1.3. The results from this are shown in section 4.3.

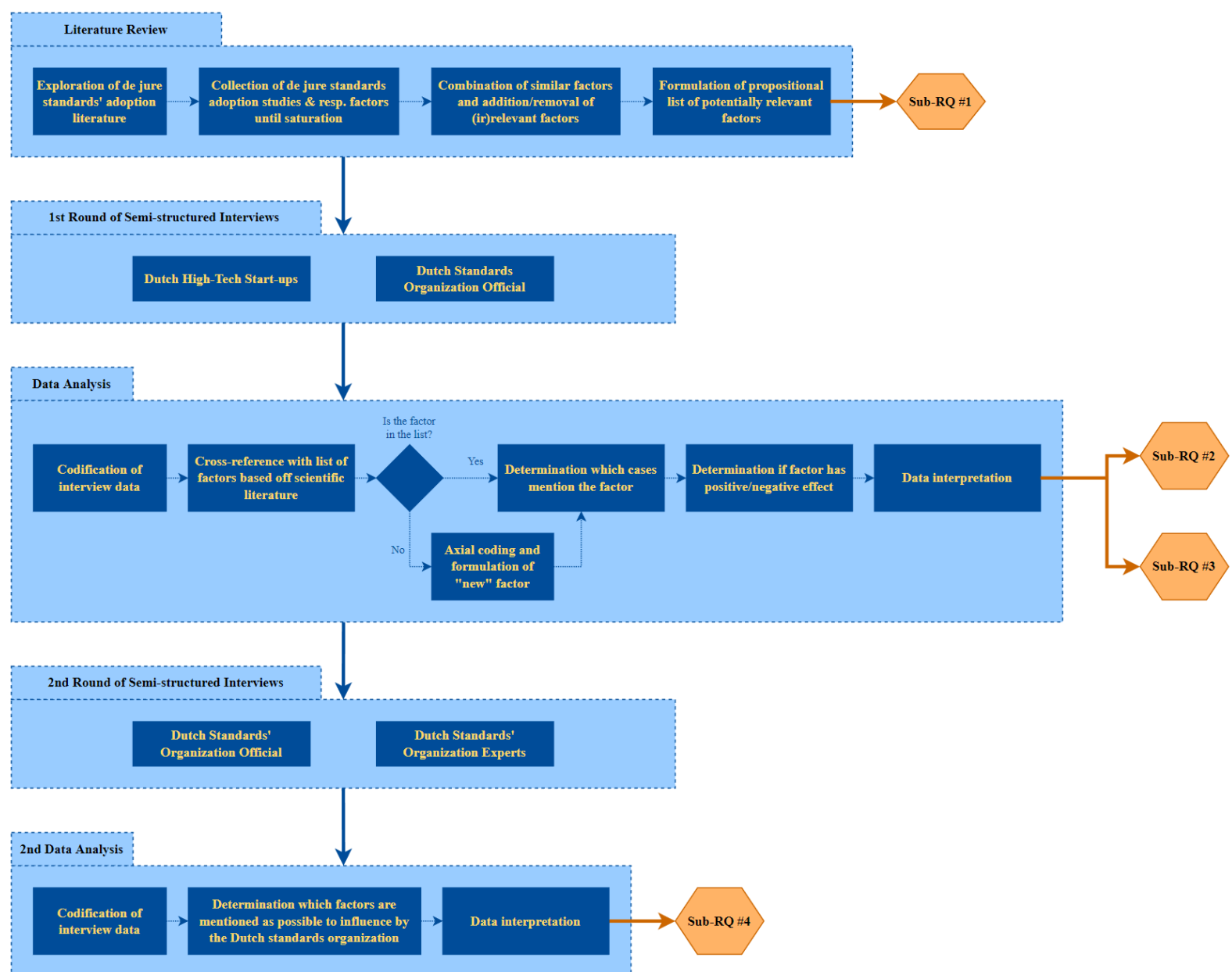


Figure 1: Overview of methodology with steps

4. Results

In this chapter, the results of the interviews and their respective rounds of data analysis will be presented. First off, in section 4.1, is the literature-backed list of potential factors for which the method of formulation is described in section 3.1 and which is elaborated on in Chapter 2. This was used as a basis for the subsequent interviews. Second, in section 4.2, are the results of the semi-structured exploratory interviews of cases 1-6 and their respective analysis. Third, in section 4.3, are the results of the semi-structured exploratory interviews of case 7-8 and their respective analysis.

4.1 – Literature-backed list of potential factors

The overview of the factors can be seen below. The selection process of the factors can be found in section 3.1. The translated descriptions of the factors and further background of the theories and frameworks are given in Chapter 2.

Factor	Explanation
Perceived characteristics of standard	
1. Relative advantage	Perceived potential benefits received from adopting the standard, relative to the prior situation, such as customer satisfaction, increases in sales and/or profit, access to new markets, or increased competitive advantage. (Rogers, 1962, 1995; Hashem & Tann, 2007)
2. Compatibility	The perceived fit of the standard with existing company values and needs. (Rogers, 1962, 1995; Hashem & Tann, 2007)
3. Complexity	The perceived difficulty of the understanding and utilization of the standard. (Rogers, 1962, 1995; Hashem & Tann, 2007)
4. Observability	The observing of the adoption of the standard of others, being able to assess the standard before adopting it themselves. (Rogers, 1962, 1995; Hashem & Tann, 2007)
5. Characteristics of external environment	
6. Competitive pressure	Pressure amongst competitors to gain competitive advantage by means of adopting the standard. (Hashem & Tann, 2007)
7. Environmental uncertainty	Uncertainty concerning the external environment of the high-tech start-up such as the future state of markets, regulations, etc. (Hashem & Tann, 2007)
8. Mimetic pressure	Pressure to mimic or imitate other organizations in situations of uncertainty and adopt the same standard. (Dimaggio & Powell, 1983)
9. Coercive pressure	Pressure imposed by external actors that is felt as force, such as demands of customers, imposed regulations etc. to adopt the standard. (Dimaggio & Powell, 1983)
10. External support	Support from thirds parties in adopting the standard, for example by means of funds or resources. (Hashem & Tann, 2007)
11. Normative pressure	Internal and/or external pressure concerning a desire for legitimacy or desired norms/values. (Dimaggio & Powell, 1983)
12. Characteristics of Organization	
13. Management support	Support from within the companies' management for the adoption of the standard. (Hashem & Tann, 2007)
14. Centralization	The degree of concentration of power within the company in a small group of individuals, such as the executive board. (Rogers, 1995; Hashem & Tann, 2007)
15. Formalization	The degree of designation and application of protocol and procedure within a company. (Rogers, 1995; Hashem & Tann, 2007)
16. Organizational size	The size of the organization, concerning not only numbers of employees but also i.e. number and concentration of establishments. (Hashem & Tann, 2007)

Table 11: Literature-backed list of potential factors

4.2 – 1st Round of semi-structured interviews

In Table 13 is presented which standards are mentioned by the different cases that were interviewed in the 1st round, as described in section 3.2. The four factors of the category “organizational characteristics” have been determined to be constants in this research, which is explained below. All companies share their experience about standards adoption in the first steps as a company. Therefore:

- The factor management support would qualify as complete, as at that point there is only management (only co-founders).
- The factor “centralization” would qualify as "complete" (completely centralized), as the firm only consists of management, or total centralization.
- The factor “formalization” would qualify as minimal/none as start-ups have little-to-no formalization in the first steps of their company
- The factor “organizational size” would qualify as very small.

These factors have been therefore kept as constants in the data analysis of this research. The following subsections show the results from the data analysis of the interview transcripts. The codification of the transcripts can be found in Appendix A.

Case	Role/position	Product	Standards mentioned
1.	Co-founder, CEO	Floating solar panel installations	CE, NEN1010, combination of standards
2.	Co-founder, CTO	Consumer-based battery-wall solutions	CE, NEN1010, NEN3140, NEN4288, IEC62933 series 5, combination of standards
3.	Co-founder, CEO	SaaS-enabled, clean energy solutions market platform	CE, UKCA, UN38.3, ISO standards in general
4.	Co-founder, Consultant	Modular housing	Not specifically mentioned, regulatory standards
5.	Co-founder, CTO	Industrial modular battery solutions	CE, ROS, Battery Directive, combination of standards
6.	Innovation, Education & New Business (3 yrs) and Senior Consultant at NEN (6 yrs.);		CE, NEN-, CEN-CENELEC- and ISO- standards in general

Table 12: Cases 1-6 and their mentioned standards

4.2.1 – Identified factors

In Table 13, the factors from the literature-backed list can be seen that were identified in the 1st round of semi-structured interviews. The codification can be found in Appendix A.1.

	High-tech. start-ups					NEN Case 6
	Case 1	Case 2	Case 3	Case 4	Case 5	
Perceived characteristics of a standard						
1. Relative advantage	Y	Y	Y	Y	Y	Y
2. Compatability	Y	Y	Y	Y	Y	Y
3. Complexity	Y	N	N	Y	Y	Y
4. Observability	N	N	N	N	N	N
Characteristics of the external environment						
5. Competitive pressure	N	N	N	N	N	N
6. Environmental uncertainty	Y	Y	Y	N	Y	Y
7. Mimetic pressure	N	N	Y	Y	Y	Y
8. Coercive pressure	Y	Y	Y	Y	Y	Y
9. External support	Y	Y	Y	N	Y	Y
10. Normative pressure	Y	Y	N	Y	Y	Y
Characteristics of Organization						
11. Management support						
12. Centralization						
13. Formalization						
14. Organizational size						

Table 13: Identified factors from literature-backed list

During the interviews it became apparent that there was a distinction between two “methods” of standards adoption: (1) the adoption of a single i.e. NEN standard, and (2) the adoption of a combination of standards. This phenomenon is explained in Chapter 5. The decision was made to split identification and effects of factors from the literature-backed list into the two “methods” of standard.

4.2.2 – Identified factors for the adoption of a single standard

In Table 14, the factors affecting the adoption of a single standard can be seen. The codification can be found in Appendix A.1.

	High-tech. start-ups					NEN Case 6
	Case 1	Case 2	Case 3	Case 4	Case 5	
Perceived characteristics of a standard						
1. Relative advantage	Y	Y	Y	Y	Y	Y
2. Compatability	Y	Y	Y	Y	Y	Y
3. Complexity	Y	N	N	Y	Y	Y
4. Observability	N	N	N	N	N	N
Characteristics of the external environment						
5. Competitive pressure	N	N	N	N	N	N
6. Environmental uncertainty	Y	Y	Y	N	Y	Y
7. Mimetic pressure	N	N	Y	Y	N	N
8. Coercive pressure	Y	Y	Y	Y	Y	Y
9. External support	N	Y	Y	N	Y	Y
10. Normative pressure	Y	Y	N	Y	Y	Y
Characteristics of Organization						
11. Management support						
12. Centralization						
13. Formalization						
14. Organizational size						

Table 14: Identified factors from literature-backed list concerning the adoption of a single standard

4.2.3 – Identified factors for the adoption of a combination of standards

In Table 15, the factors affecting the adoption of a combination of standards can be seen. Case 3 and Case 4 did not mention the adoption of a combination of standards and are therefore left blank. The codification can be found in Appendix A.1.

	High-tech. start-ups					NEN
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Perceived characteristics of a standard						
1. Relative advantage	Y	Y			Y	N
2. Compatability	Y	Y			Y	Y
3. Complexity	Y	N			N	N
4. Observability	N	N			N	N
Characteristics of the external environment						
5. Competitive pressure	N	N			N	N
6. Environmental uncertainty	Y	Y			Y	Y
7. Mimetic pressure	N	N			Y	N
8. Coercive pressure	Y	Y			Y	Y
9. External support	Y	Y			Y	Y
10. Normative pressure	Y	Y			N	N
Characteristics of Organization						
11. Management support						
12. Centralization						
13. Formalization						
14. Organizational size						

Table 15: Identified factors from literature-backed list concerning the adoption of a combination of standards

4.2.4 – Effects of factors for the adoption of a single standard

In Table 16, the effects of factors on the adoption of a single standard can be seen. Factors that were not identified in Table 14 were left blank. The codification can be found in Appendix A.1.

	High-tech. start-ups					NEN
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Perceived characteristics of a standard						
1. Relative advantage	+	+	+	+	+	+
2. Compatability	+	+	+	+	+	+
3. Complexity	-			-	-	-
4. Observability						
Characteristics of the external environment						
5. Competitive pressure						
6. Environmental uncertainty	+	+	+		+	+
7. Mimetic pressure			+	+		
8. Coercive pressure	+	+	+	+	+	+
9. External support		+	+		+	+
10. Normative pressure	+	+		+	+	+
Characteristics of Organization						
11. Management support						
12. Centralization						
13. Formalization						
14. Organizational size						

Table 16: Identified effects of factors from literature-backed list concerning the adoption of a single standard

4.2.5 – Effects of factors for the adoption of a combination of standards

In Table 17, the effects of factors on the adoption of a combination of standards can be seen. Factors that were not identified in Table 15 were left blank. The codification can be found in Appendix A.1.

	High-tech. start-ups					NEN Case 6
	Case 1	Case 2	Case 3	Case 4	Case 5	
Perceived characteristics of a standard						
1. Relative advantage	+	+			+	
2. Computability	+	+			+	+
3. Complexity	-					
4. Observability						
Characteristics of the external environment						
5. Competitive pressure						
6. Environmental uncertainty	+	+			+	+
7. Mimetic pressure					+	
8. Coercive pressure	+	+			+	+
9. External support	+	+			+	+
10. Normative pressure	+	+				
Characteristics of Organization						
11. Management support						
12. Centralization						
13. Formalization						
14. Organizational size						

Table 17: Identified effects of factors from literature-backed list concerning the adoption of a combination of standards

4.2.6 – Axial, thematic codification and formulation of new propositional factors

Where factors were identified by interviewees that are not included in the literature-based list, axial coding was applied. This was done by coding thematically and then grouping the factors according to these themes. The themes became the new propositional factors mentioned in the table below. The codification can be found in Appendix A.2. The interviews were again investigated if the new factors were identified. Propositions were added to these to be able to test if the interviewees mentioned a positive or negative effect on adoption. The propositions were based on the influence the interviewees mentioned.

Other factors named	Definition	Potential proposition
1. Awareness/Prior knowledge	Awareness/prior knowledge concerning the standard itself or its adoption process.	<i>The more awareness/prior knowledge the high-tech start-up has concerning the standard and its adoption process, and/or the higher the quality, has a positive effect on the adoption of the standard.</i>
2. Processual characteristics	Characteristics relating to the process of adoption of the standard such as complexity and duration.	<i>A less complicated or long process of adoption of the standard has a positive effect on the adoption of the standard.</i>
3. Trust in evolution of standard	Trust by the high-tech start-up in the evolution of the standard by the respective development committee, i.e., that the start-ups product remains within the scope of the standard.	<i>Higher trust in the evolution of the standard in its respective standards committee has a positive effect on the adoption of the standard.</i>
4. Costs	Costs of the standard itself, but also of the adoption process (i.e., testing of the product).	<i>A higher cost of the standard and/or its adoption process has a negative effect on the adoption of the standard.</i>

Table 18: Newly mentioned propositional factors

4.2.7 – Identified new propositional factors

Table 19 presents the identified new propositional factors, as identified in the 1st round of semi-structured interviews. Case 4 did not mention any factors that were not already included in the literature-backed list. This has been incorporated in the table as an “N” for -not identified- but has been put in grey. As is explained in Appendix A.2, the factors of “processual characteristics” and “costs” have an asterisk as they were not identified in Case 6 but in Case 8. As these are the same NEN official, these were included, nonetheless.

	High-tech. start-ups					NEN
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Other factors named						
1. Awareness/Prior knowledge	Y	Y	N	N	Y	Y
2. Processual characteristics	Y	Y	N	N	Y	Y*
3. Trust in evolution of standard	Y	Y	Y	N	Y	Y
4. Costs	N	Y	N	N	Y	Y*

Table 19: Identified new propositional factors

4.2.8 – Effects of new propositional factors

Table 20 presents the effects of the new propositional factors, as identified in the 1st round of semi-structured interviews. As is explained in Appendix A.2, the factors of “processual characteristics” and “costs” have an asterisk as they were not identified in Case 6 but in Case 8. As these are the same NEN official, these were included, nonetheless.

	High-tech. start-ups					NEN
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Other factors named						
1. Awareness/Prior knowledge	+	+			+	+
2. Processual characteristics	+	+			+	+
3. Trust in evolution of standard	+	+	+		+	+
4. Costs		-			-	-*

Table 20: Identified effects of new propositional factors

4.2.9 – Overview of identified factors

An overview of all identified factors can be seen in Table 21. Factors 1-14 are split into the two “methods” of standards: single standards adoption and the adoption of a combination of standards. As is explained in Appendix A.2, the factors of “processual characteristics” and “costs” have an asterisk as they were not identified in Case 6 but in Case 8. As these are the same NEN official, these were included, nonetheless.

	Case 1		Case 2		High-tech. start-ups Case 3		Case 4		Case 5		NEN Case 6	
	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.
Perceived characteristics of a standard												
1. Relative advantage	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y
2. Compatibility	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y
3. Complexity	Y	Y	N	N	N		Y		Y	N	Y	N
4. Observability	N	N	N	N	N		N		N	N	N	N
Characteristics of the external environment												
5. Competitive pressure	N	N	N	N	N		N		N	N	N	N
6. Environmental uncertainty	Y	Y	Y	Y	Y		N		Y	Y	Y	Y
7. Mimetic pressure	N	N	N	N	Y		Y		N	Y	N	N
8. Coercive pressure	Y	Y	Y	Y	Y		Y		Y	Y	Y	Y
9. External support	N	Y	Y	Y	Y		N		Y	Y	Y	Y
10. Normative pressure	Y	Y	Y	Y	N		Y		Y	N	Y	N
Characteristics of Organization												
11. Management support												
12. Centralization												
13. Formalization												
14. Organizational size												
Other factors named												
15. Awareness/Prior knowledge	Y		Y		N		N		Y		Y	
16. Processual characteristics	Y		Y		N		N		Y		Y*	
17. Trust in evolution of standard	Y		Y		Y		N		Y		Y	
18. Costs	N		Y		N		N		Y		Y*	

Table 21: Overview of identified factors, split into single- and combination standards adoption

4.2.10 – Overview of effects of factors

An overview of all identified effects on factors can be seen in Table 22. Factors 1-14 are split into the two “methods” of standards: single standards adoption and the adoption of a combination of standards. As is explained in appendix section A.2, the factors of “processual characteristics” and “costs” have an asterisk as they were not identified in Case 6 but in Case 8. As these are the same NEN official, these were included, nonetheless.

	Case 1		Case 2		High-tech. start-ups Case 3		Case 4		Case 5		NEN Case 6	
	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.	Single	Comb.
Perceived characteristics of a standard												
1. Relative advantage	+	+	+	+	+		+		+	+	+	+
2. Compatibility	+	+	+	+	+		+		+	+	+	+
3. Complexity	-	-					-		-		-	
4. Observability												
Characteristics of the external environment												
5. Competitive pressure												
6. Environmental uncertainty	+	+	+	+	+				+	+	+	+
7. Mimetic pressure					+		+			+		+
8. Coercive pressure	+	+	+	+	+		+		+	+	+	+
9. External support		+	+	+	+				+	+	+	+
10. Normative pressure	+	+	+	+			+		+		+	
Characteristics of Organization												
11. Management support												
12. Centralization												
13. Formalization												
14. Organizational size												
Other factors named												
15. Awareness/Prior knowledge	+		+						+		+	
16. Processual characteristics	+		+						+		+	
17. Trust in evolution of standard	+		+		+		+		+		+	
18. Costs			-						-		-	

Table 22: Overview of identified effects of factors, split into single- and combination standards adoption

4.2.11 – Final list of identified factors

The list that can be seen in Table 23 consists of all the factors identified in the 1st round of semi-structured interviews. This is comprised out of the identified factors from the literature-backed list of factors from section 4.1, with the removal of “Observability” and “Competitive pressure” as they are not identified, and with the newly formulated propositional factors added.

Factor	Explanation
Perceived characteristics of standard	
1. Relative advantage	Perceived potential benefits received from adopting the standard, relative to the prior situation, such as customer satisfaction, increases in sales and/or profit, access to new markets, or increased competitive advantage. (Rogers, 1962, 1995; Hashem & Tann, 2007)
2. Compatibility	The perceived fit of the standard with existing company values and needs. (Rogers, 1962, 1995; Hashem & Tann, 2007)
3. Complexity	The perceived difficulty of the understanding and utilization of the standard. (Rogers, 1962, 1995; Hashem & Tann, 2007)
Characteristics of external environment	
4. Environmental uncertainty	Uncertainty concerning the external environment of the high-tech start-up such as the future state of markets, regulations, etc. (Hashem & Tann, 2007)
5. Mimetic pressure	Pressure to mimic or imitate other organizations in situations of uncertainty and adopt the same standard. (Dimaggio & Powell, 1983)
6. Coercive pressure	Pressure imposed by external actors that is felt as force, such as demands of customers, imposed regulations etc. to adopt the standard. (Dimaggio & Powell, 1983)
7. External support	Support from thirds parties in adopting the standard, for example by means of funds or resources. (Hashem & Tann, 2007)
8. Normative pressure	Internal and/or external pressure concerning a desire for legitimacy or desired norms/values. (Dimaggio & Powell, 1983)
Characteristics of Organization	
9. Management support	Support from within the companies’ management for the adoption of the standard. (Hashem & Tann, 2007)
10. Centralization	The degree of concentration of power within the company in a small group of individuals, such as the executive board. (Rogers, 1995; Hashem & Tann, 2007)
11. Formalization	The degree of designation and application of protocol and procedure within a company. (Rogers, 1995; Hashem & Tann, 2007)
12. Organizational size	The size of the organization, concerning not only numbers of employees but also i.e. number and concentration of establishments. (Hashem & Tann, 2007)
New propositional factors	
13. Awareness/Prior knowledge	Awareness/prior knowledge concerning the standard itself or its adoption process.
14. Processual characteristics	Characteristics relating to the process of adoption of the standard such as complexity and duration.
15. Trust in evolution of standard	Trust by the high-tech start-up in the evolution of the standard by the respective development committee, i.e., that the start-ups product remains within the scope of the standard.
16. Costs	Costs of the standard itself, but also of the adoption process (i.e., testing of the product).

Table 23: Final list of identified factors

4.3 – 2nd Round of semi-structured interviews

These results concern the 2nd round of semi-structured interviews, wherein the aim was to identify which factors the respective cases identify as possible to influence by the Dutch standards organization (NEN). The list of interviewees can be found in section 3.4.1. A description of the questions can be found in section 3.4.2. The codification of these transcripts can be found in Appendix B.

4.3.1 – Factors identified as possible to influence

Table 24 shows which factors were identified by Case 7 and Case 8 as possible to influence. The two separate interviews, the first with the two ex. CEN/TC 278 committee members and the second with the NEN official revealed four factors up for discussion. The four factors identified were (1) coercive pressure, (2) awareness/prior knowledge, (3) trust in the evolution of the standard and (4) costs. The codification and corresponding statements can be found in Appendix B.

	Experts Case 7	NEN Case 8
Perceived characteristics of a standard		
1. Relative advantage		
2. Compatability		
3. Complexity		
4. Observability		
Characteristics of the external environment		
5. Competitive pressure		
6. Environmental uncertainty		
7. Mimetic pressure		
8. Coercive pressure	Y	
9. External support		
10. Normative pressure		
Characteristics of Organization		
11. Management support		
12. Centralization		
13. Formalization		
14. Organizational size		
Other factors named		
15. Awareness/Prior knowledge		Y
16. Processual characteristics		
17. Trust in evolution of standard	Y	
18. Costs		Y

Table 24: Factors identified as possible to influence

4.3.2 – How these factors can be influenced

The statements mentioned by the interviewed experts and NEN official on how the factors can be influenced can be found in Appendix B. The statements will be discussed section 5.1.3.1.

5. Discussion

This chapter aims at evaluating this research and discussing its various aspects. The research methods will be addressed in respective order, addressing each steps limitations and future recommendations, and concluding this chapter with a discussion on this research's theoretical and practical contribution.

5.1 – Interpretation of results

5.1.1 – Literature review

The literature search and subsequent formulation of the literature-backed list of factors affecting de jure standards adoption as described in section 3.1 and 4.1, respectively, resulted in a list of factors from three recurring main theories applied in studies concerning ISO standards adoption. These three are the DOI approach as formulated by Rogers (Rogers, 1962; 1995), the “Network Economics” approach of Katz & Shapiro (Katz & Shapiro, 1986) and Farrell & Saloner (Farrell & Saloner, 1985) incorporated the TOE framework as formulated by Tornatzky & Fleischer (Tornatzky & Fleischer, 1990) and the NI (neo-institutional) theory as formulated by Meyer & Rowan (Meyer & Rowan, 1977) and elaborated on by Dimaggio & Powell (Dimaggio & Powell, 1983). This eventual list is the same as the one used in (Hashem & Tann, 2007), which was hypothesis-tested. Therefore, the results of this research can be interpreted and compared to the literature: the previously mentioned theories, frameworks and their respective factors.

5.1.2 – 1st Round of semi-structured interviews

In this section, the interpretation of the results of the 1st round of semi-structured interviews will be presented. First of all, the factors from the literature-backed list in section 4.1 that were identified will be addressed. Second, the distinction between single standards adoption and the adoption of a combination of standards will be addressed. Third, the newly found propositional factors will be addressed. Finally, the theoretical contribution of this section will be reviewed.

5.1.2.1 – Identified factors

In section 4.2.1. can be seen which factors were identified by Cases 1-6. Factors that are distinctly mentioned in all cases are “Perceived relative advantage”, “Compatibility” and “Coercive pressure”. Factors that are distinctly not mentioned in any of the cases are “Observability” and “Competitive pressure”. It can be determined that the results for “Perceived relative advantage”, “Compatibility” and “Coercive pressure” (referred to as “external pressure by Hashem & Tann) coincide with the results of (Hashem & Tann, 2007), namely that they have a positive effect on standards adoption. The factor “Observability” not being identified in any of the cases likewise coincides with the results of (Hashem & Tann, 2007).

Where this does not coincide however, is with the factor “Competitive pressure”. Competition was not mentioned in any of the cases, whilst this factor having affect was supported by the results in (Hashem & Tann, 2007). The difference could be due to the different types of firms

tested. The target research pool for (Hashem & Tann, 2007) were Egyptian manufacturing companies whereas here it is specifically Dutch high-tech start-ups. Explanations could therefore be that as the high-tech start-ups are so young that they have not dealt with competition yet. Another explanation could be that the innovative product is so unique that there is no direct competition (yet).

The factor environmental uncertainty was identified in each case except in Case 4. This could be considered an outlier as it is only one of the six and (after splitting the “method” of standards adoption) it is identified in each single and combination case except Case 4, giving it more generalizability within this research. In each identification it is mentioned as a positive factor and therefore there is first evidence that it appears to be that environmental uncertainty has a positive effect on de jure standards adoption. This would appear to go against the results of (Hashem & Tann, 2007) in that they found that environmental uncertainty did not have a significant relationship with standards adoption. This could however, as well be explained through the difference in research pool, as the high-tech start-ups experience more uncertainty due to the innovative nature of their product and there being no specific standard for their product.

5.1.2.2 – Distinction between the adoption of a single standard and of a combination of standards

During the interviews it became apparent that there was a distinction between two “methods” of standards adoption: (1) the adoption of a single, i.e., NEN standard, and (2) the adoption of a combination of standards. This combination of standards is due to the fact that there was no specific standard yet for their respective product, and so, for different motivations, they adopt a combination of standards that each are relevant to a certain sub-aspect of the product. As a group of relevant standards, the start-up has “standardized” their product “as much as possible”. Due to this distinction, the identified factors were split into identified factors affecting the adoption of a single de jure standard and identified factors affecting the adoption of a combination of de jure standards.

Many factors are identified in both cases but there are some notable differences from which propositions can be made.

External support

Case 1 does not mention “External support” with regards to the adoption of a single standard, as does Case 4, but does with regards to the adoption of a combination of standards. This could be due to the fact that Case 1 already had years of experience in the industry and with its standardization, meaning they did not need external support. In addition, the rest of the cases mention external support in both contexts, and all instances identify it as having a positive effect, which can be interpreted as that all cases identify that external support has a positive influence on the adoption of the de jure standard (or combination thereof) if the high-tech start-up itself does not have significant experience in the industry already. If a case does not mention external support with regards to the adoption of a single standard, so if the start-up already has significant experience in the industry and its standardization (as is the case with Case 1), external support is named with regards to the adoption of a combination of

standards. Even though the research pool is too small to be able to formulate a proposition within this research, a potential proposition could be made that the “method” of standards adoption (single vs. combination) has a moderating effect on external support.

In addition to this, external support is named in every instance where there was mention of the adoption of a combination of standards, and in each instance that it is mentioned, a positive effect was identified. This means that a 2nd proposition can be made, namely that external support has a positive effect on the adoption of a combination of standards. This is contrary to the finding of (Hashem & Tann, 2007), namely that external support had no significant relation.

Complexity

In Case 5 and Case 6, “Complexity” is mentioned with regards to the adoption of a single standard but not with regards to the adoption of a combination of standards. In these cases, it is mentioned that the single standard that the companies aim to adopt is very complex. Therefore, they aim to adopt a combination of sub-aspect standards instead. This combination then consists of standards that are not complex, the reason that complexity is not mentioned with regards to the combination. The only case that does mention complexity with regards to the combination of standards is Case 1, but not that they experienced complexity themselves, quite the contrary. As can be seen below, they mention that it could have a negative influence but that it was not in their case. Therefore, it can be proposed that the difference in “method” of standards adopted (single vs. combination) has a moderating effect on complexity.

“That’s always nice, so there isn’t a lot of standardization imposed from the outside, other than that you have to land with 66kV or those kinds of requirements, but that’s what it’s all about: the cables and the inverters and transformers you use.” (Case 1)

Normative pressure

All cases mention “Normative pressure” with regards to the adoption of a single standard except Case 3. This could be regarded as an outlier (there is a chance that the interviewee did not think of the factor, but it was one), which, as it is in each instance identified as having a positive effect, would appear to lead to the potential proposition that normative pressure has a positive effect on the adoption of a single de jure standard. The same cannot be said for the effect normative pressure has on the adoption of a combination of standards. Therefore, another potential proposition appears to be that the “method” of standards adoption (single vs. combination) has a moderating effect on normative pressure.

5.1.2.3 – New propositional factors

In review, the cases identified factors that were not in the literature-backed list. These factors were axially (thematically) codified to generate four new potential propositional factors: (1) awareness/prior knowledge, (2) processual characteristics, (3) trust in evolution of standard and (4) costs. The codification can be found in Appendix A.2. The definitions can be found in section 4.2.6. The interviews transcripts were codified a second time to determine who

identified these new propositional factors and what their identified effect was on standards adoption, which can be seen in 4.2.7 and 4.2.8. These factors will be assessed and interpreted here, as well as their effects. It should be noted that Case 4 did not mention any new factors and therefore is excluded from the interpretation. Thus, the cases analyzed in this section only consider Cases 1-3, 5 and 6.

5.1.2.3.1 – Awareness/Prior knowledge

This factor was identified by all cases except Case 3. All mentions were of a positive effect on the adoption of standards. Therefore, a proposition can be made: awareness/prior knowledge of the standard and its adoption process result in a positive effect on the adoption. Important to note here is that it does not concern only knowledge surrounding the standard itself and its characteristics but also its adoption process. This proposition coincides with the “knowledge stage” of the DOI formulated by Rogers (Rogers, 2003) but there is a distinction. The knowledge stage of Rogers consists of “awareness-knowledge”, “how-to-knowledge” and “principles-knowledge”, none of which cover knowledge of the adoption process itself. The process of adoption could have certain characteristics such as duration and complexity (covered in the next section) that, if negative, could influence the decision to adopt. This means that the awareness of the processual characteristics also affects the adoption of de jure standards adoption.

5.1.2.3.2 – Processual characteristics

Mentioned in the previous paragraph is so-called processual characteristics. This concerns characteristics such as the duration and complexity of the adoption process, such as the testing of the product. These characteristics could be known beforehand (depending on multiple other variables such as external support) and could influence the decision to adopt. These characteristics are partially covered by (Boiral et al., 2018) with “time constraints”, as if the high-tech start-up does not have the time for a two-year certification process, it might not adopt it. Amongst the research pool, it is identified by all except Case 3, and when identified, identified as a positive effect. Therefore, the proposition can be made that processual characteristics (as described in section 4.2.6) have a positive effect on de jure standards adoption.

5.1.2.3.3 – Trust in evolution of standard

This factor concerns the trust that high-tech start-ups have in the future evolution, or re-evaluation of the relevant standard for their product in the respective standards committee. This could be, for example, trust that the product remains within the scope of the standard and is not omitted. This is partly related to the “Maturity of certification” factor of (Boiral et al., 2018). There are multiple aspects to this that are mentioned in Appendix A.2.3. Amongst the respondents it is unanimously identified, and as a positive factor. Therefore, the proposition can be made that “trust in evolution of standard” (as formulated in 4.2.6) has a positive effect on de jure standards adoption.

5.1.2.3.4 – Costs

This factor concerns the costs associated with the standard and its adoption process. An example of these costs of the adoption process could be the costs of destructively tested products (as mentioned in Case 5). This factor is partially covered in (Boiral et al., 2018) with “costs and lack of resources”, but the interpretation in this research is that this has multiple aspects. Of the respondents, half identified this as a factor, and did so with a negative context.

5.1.2.4 – Theoretical contribution

In the respective previous sections is mentioned where the identification of the factors coincides or clashes with the literature, with their explanation. The factors of “perceived relative advantage”, “compatibility”, “coercive pressure” and “observability” coincide with the literature. The factors “external support” only coincides with the literature in the context of the adoption of a single standard. The factors “competitive pressure” and “environmental uncertainty” do not coincide with the literature. The “method” of standards adoption (single vs. combination) has a moderating effect on “external support”, “complexity” and “normative pressure”. Of the new propositional factors, “awareness/prior knowledge”, “processual characteristics” and “trust in evolution of standard” have been identified as actual propositions affecting the adoption of standards.

5.1.3 – 2nd Round of semi-structured interviews

To review, a second round of interviews were held with three standards’ organization experts. These were as well semi-structured, explorative interviews, aiming to discover if there are factors that the NEN and the CEN identify as possible to influence by the Dutch standards organization, how so, and, concerning the NEN, if there are initiatives in play by the organization at the moment. An expansion is given on which factors they identify as possible to influence and if there are initiatives, respectively.

5.1.3.1 – Factors identified as possible to influence

The identified factors that are possible to influence can be found in section 4.3.1. In summary, the factors of “coercive pressure”, “awareness/prior knowledge”, “trust in evolution of standard” and “costs” were identified as possible to influence.

5.1.3.2 – How these factors can be influenced

In this section, the factors will be addressed in order on how they can be influenced.

5.1.3.2.1 – Coercive pressure

This factor was identified by the ex. CEN/TC 278 committee members. When regarding coercive pressure from financial institutions, such as insurance firms that demand standards as a guarantee, the pressure may seem strict from the start-up’s point of view but, as the ex. CEN committee members state, those demands might be easier met than initially thought, especially in the case of a combination of standards. In this case, they say, not necessarily all relevant standards are required but maybe only the most relevant ones. A combination consisting of a smaller amount of the more relevant standards could be sufficient to comply

with those demands. For the high-tech start-up to know of this, greater awareness/prior knowledge is needed. The company needs to know with which standards to comply and that the coercive pressure is only applied to these, on not all compatible standards. In this way, the factor of coercive pressure could be influenced by awareness/prior knowledge.

“I can imagine that if they want financing, the financier will ask them what the product is, and if it complies with the standards. They don’t know, because there aren’t any standards yet, and then they hire a company to find the needles in the haystack to see what the most relevant standards are and then they compile these partly and say “look, we already have this”, hoping that the financier and insurer can be persuaded that it is a solid base.” (Case 7)

The interviewees of Case 7 also set forth that there is certainly coercive pressure enacted on high-tech start-ups by the Dutch government. This coercive pressure is very strict (mandatory legislature) but when complied with, the consequence is that the entire European market becomes available for the respective product. The strict regulations impose standards with respect to quality but also safety and by doing so, prevent unmonitored goods from entering the European market, therefore guaranteeing the populace high quality and safe products. The reverse is also true, that when these regulations are met, the entire European market is open, and with that the company can achieve greater market penetration. Therefore the negative effect of coercive pressure on the adoption of the standard can be influenced by a greater perceived relative advantage (access to new markets).

“... it even goes so far that in the Netherlands or even in Europe, that if you adhere to the standard once, you can sell your product in all the member states within the EU. With this you have achieved market penetration.” (Case 7)

5.1.3.2.2 – Awareness/Prior knowledge

Multiple aspects of awareness/prior knowledge are addressed. These are (1) awareness of standardization itself, (2) awareness of which standards suit the product and (3) awareness of external support. These will be addressed in respective order.

Awareness of standardization itself

As set forth in the previous quote, standardization might not be an evident aspect of the beginning steps for a start-up. This while the consequences could be dire if the product does not comply with certain mandatory standards and therefore cannot be sold on the market (such as the CE certification). From the interview of Case 8 it can be taken that the main focus of the NEN on influencing factors deals with awareness. The initiative is one with a focal point on education, at incubators but also through guest lectures or courses at universities. Another angle for them to approach it is through the financial institutions that exert coercive pressures such as insurance companies, who actively approach the NEN and enquire about relevant standards.

“Yes, I think that most don’t concern themselves with it at all at the beginning, they don’t realize it yet, they’re focused fully on their product.” (Case 8)

“Education, so that attention is paid to it in education. Or that he got that from his incubator or the location where it is. That can be different sources, it can also be

financiers or investors who draw his attention to this or simply ask the question about it.” (Case 8)

Awareness of what can be achieved with standards

What can be achieved with standards is as well an aspect that the NEN aims to address with education. The previously mentioned courses sometimes also consist of practice sessions with the database of the NEN, “NEN connect”. A start-up struggle that was mentioned is that the start-up does not realize what all is possible when having adopted a standard, for example if the company aims to expand from the Dutch market to an international market, whilst the standard could already be compatible with international demands (especially in the EU).

“It’s about: “I have a product on the market and I want to go international, how can I grow internationally with the help of the organization?” That can sometimes be an important instrument, all those kinds of aspects.” (Case 8)

Awareness of which standards suit the product

As is clear from the fact that multiple high-tech start-ups amongst the case studied in this research have acquired combinations of standards, it is often unclear which standards apply to the product of the company, especially with high-tech start-ups with an innovative product. Case 5 mentioned the lack of a database with an overview of all the standards that apply to your respective product, this is a perfect example of a lack of awareness in this manner. The “NEN connect” database has all standards that apply to the Netherlands, but also CEN-CENELEC standards, ISO standards, German standards and American standards (not necessarily all however). This aspect of lack of awareness the NEN similarly aims to address with education and practice sessions.

“For example in our database, NEN connect. You can search there. Just like Espacenet, where you can search for patents, you can search for the relevant standards in NEN connect. But then it must be known that NEN connect exists.” (Case 8)

Awareness of external support

Sometimes the lack of awareness can go so far as that the start-up does not even know of the existence of the NEN. Even when they do know of the institution, they might not realize that part of its goal is to assist with their standardization needs, in multiple ways. This is of course the responsibility of the high-tech start-up itself but, similarly to what was previously mentioned, the NEN applies marketing through educational institutions to address this.

“At the same time, you need to know that the NEN can help you with that.” (Case 8)

5.1.3.2.3 – Trust in evolution of standard

Another factor derived from the interviews with high-tech start-ups was “trust in the evolution of the standard”, meaning that the evaluation of a standard by a start-up might also depend on

the attitude the start-up has formed concerning the standards' future development (in a standards' committee) and if the start-up trusts that their product will remain in the scope of the standard, e.g., not be excluded from the market.

The trust in the evolution of the standard has multiple aspects, those mentioned are (1) if the standard is or remains up-to-date and (2) the authority of the standard.

“That is actually a good point, because the standardization we took part in was formal standardization, which is characterized by long procedures and that works very well for the traditional processes, products, for example the engine of a car lasts for decades but the tech-sector for sure, those are things that move quickly, the developments of formal standards would never be able to keep up.” (Case 7)

As can be read above, there is the possibility that a standard is not up-to-date due to the slow speed of the respective standardization committee. Case 2 and 5 mentioned problems with this aspect, namely that (for Case 5) the coercive pressure enacted upon them by a governmental institution was that they comply with a battery standard that was meant for electric vehicles, when their product did not have anything to do with vehicles. The issue was that the standard was not up-to-date and that there was not another, more relevant, standard. Aspects such as this significantly lower the trust of the start-up in acquiring the standard.

A way of influencing this factor, as set forth by Case 8, is that a start-up does not necessarily have to adopt a formal standard such as NEN, CEN-CENELEC or ISO, but that there are other standardization institutions that are more focused to a certain industry, such as IEEE with digital standardization. These consortiums can formulate standards much quicker, the committee members say, as their formation originated from the need for a quicker formalization process.

“Yes, of course there are the formal institutions such as CEN or ISO but there are also others such as IEEE for, for example, Wi-Fi standards and that is a consortium, often they're consortiums, more for larger companies but startups can of course also partake. But yes, inside ISO it goes very slowly. Sometimes another platform is needed because a new standard needs to be made every two months and it needs to be checked quickly so that everybody can move on. And that's why such initiatives have sprouted and some of them, such as IEEE, are now so large, they already have thousands of members, but they can also standardize very quickly, or make decisions. So yeah, eventually people find each other right, they say: “This is what we're struggling with, we need to agree of a basis, it helps all of us if we have agreements concerning it, because it then enables compatibility, or we know what we have to comply with”. And then you see that this different type of initiatives also come into existence.” (Case 7)

On the other hand, the authority of these standards is a direct derivative of the organization that has formulated them. In turn, the authority that that respective organization has determines the authority of the standards when dealing with coercive pressures such as financial institutions and the question could remain if the authority of the selected and adopted standard is then enough to satisfy the requirement of the respective coercive pressure.

“... and that's where, more often, you see initiatives outside of formal standardization, to give that substance. However, if new parties do this then there is an added disadvantage that the

insurer might not accept the standard of these parties if they have not yet been accepted by peers.” (Case 7)

5.1.3.2.4 – Costs

The last aspect addressed in the interviews of Case 7 and 8 was cost. This might seem an obvious factor for start-ups but there are multiple dimensions in which cost affects standards' adoption as well as multiple ways with which the NEN tries to influence this. Firstly, as covered earlier, the database, “NEN connect”, is not completely open to everyone, while it is the main Dutch database for standards. Case 2 mentioned that the cost of a subscription to this database is significant for a start-up and the only way to realistically identify all relevant standards. This could provide a major barrier for start-ups when regarding the multiple potential coercive pressures that could come into play.

The NEN aims at alleviating this duress by making “NEN connect” free at certain universities (on contractual bases), where they assume many start-ups originate, or at least some members of said start-up, especially with respect to high-tech start-ups. For the rest of the public, access to the database has been made free-of-charge as well but downloading the list of requirements (e.g., a manual for the standard) is not. To assist here as well, the NEN has made certain standards and their manuals completely accessible free-of-charge.

“...it is actually necessary to be able to see those standards, and they don't all cost money, quite a few are also free. You can see the table of contents, so that you get an idea of what exactly it says.” (Case 8)

5.1.3.3 – Theoretical contribution

- **Coercive pressure**

Contrary to the definition of coercion, it is found that coercive pressure, or the way in which it is felt/interpreted by the high-tech start-up, can indeed be influenced. Through increased awareness of the relevant standards and which of the standards are needed to satisfy the coercive actor, the level of pressure can be concretely measured instead of feeling a coercive pressure to adopt everything possible. This result also contradicts Roger's definition in that the term is not possible to influence (Rogers, 1962).

- **Awareness/Prior knowledge**

The NEN aims to influence awareness through education. However, there is no mention of the nature of the education. Education concerning the adoption process of the standard and the reasons for standardization, especially in the case of a combination of standards is an aspect that is not covered by the NEN. So-called “know-why” knowledge is needed (Seemann, 2003).

- **Trust in evolution of standard**

This factor partly relates to the “Maturity of certification” mentioned in (Boiral et al., 2018), about which is stated that the internalization of a standard is greater the longer the company has the certification. If we relate this to the terms of a specific product standard for the high-tech start-ups, the tendency of adoption of the standard will increase the longer and more concrete the standard is. If this standard is very new and has not been around long, the high-tech start-up could experience uncertainty and decide not to adopt it (yet).

- **Costs**

As is mentioned in (Boiral et al., 2018), the aspect of costs for the implementation of a standard could maybe even urge certain organizations to adopt a standard symbolically instead of completely (Boiral et al., 2018). If these costs were lower, the tendency to adopt the standard entirely would become more appealing. This coincides with the manner in which the NEN is partially influencing the factor of costs. However, influencing the costs of the adoption process, especially in the case of adopting a combination of standards could comprise of a more complex dynamic due to the larger amount of stakeholders and their own respective processes.

5.2 – Limitations

In this section, the limitations of this research will be addressed. These consist of (1) generalizability, (2) the non-dichotomous nature of standards and (3) lack of further data.

5.2.1 – Generalizability

Since this is explorative research, the results of this research are not generalizable. Similarly, little can be said concerning the representativeness due to the small pool of interviewees. However, the nature is to explore different avenues and angles specific to this scope. Future research would need to be conducted to apply any kind of generalizability.

5.2.2 – The non-dichotomous nature of standards

There is also a limitation mentioned in the theory that was investigated concerning Rogers (Rogers, 1962) and his 5-step innovation adoption process, namely the dichotomous nature of adoption. This means that there are two options, having adopted the standard or not, nothing in between (Hovav et al., 2004). Especially when speaking of a combined set of standards, there is a distinction that needs research here as well, namely that standards adoption is not dichotomous but that a high-tech start-up could also only adopt a subset of the combination of standards and/or only partially comply to standards criteria.

5.2.3 – Lack of further data.

As this is a case study, triangulation between multiple sources of data is preferred and adds to the authority of the research. However, it was found that there was very little background information concerning the cases as the experiences they shared were of standardization in the

early steps of their company. If there had been more background information, such as internal documents, in-depth news articles etc., the study would have had a greater pool of data to triangulate with. In this research it is limited to scientific theory combined with the 2 rounds of interview data. It should be noted that the 1st round of interviews was all started off with a request for an introduction and back story to their respective high-tech start-up, to add to context in that manner.

5.3 – Future recommendations

The first recommendation for future research would be to interview a larger pool size. With this, potential hypothesis-testing research could also be conducted. Next to this, the pool should contain a larger mix of industries, such as high-tech start-ups from the medical industry, to determine if there is a significant difference between industries as well. Research could also be done into how different levels of prior knowledge affect the standards' adoption factors amongst high-tech start-ups. Next to this, research could be done into the external pressures aspect of standards adoption amongst high-tech start-ups. As multiple different pressure actors were identified in this research (governments, insurances firms, banks, customers), research could be done into the difference of enacted pressures between these actors and the responsive effect it has on the *de jure* adoption rate of the high-tech start-ups.

5.4 – Contribution

5.4.1 – Theoretical contribution

Firstly, concerning the theoretical contribution, the goal was to build upon scientific literature by exploring an avenue for which there is very little to no literature, namely *de jure* standards in combination with the specific scope of high-tech start-ups. The goal was to provide an explorative basis upon which future research can be done. Not only was it explored if high-tech start-ups identified factors for standards' adoption that originate from existing literature, but potential new factors were formulated as well. In section 5.1.2.4 and 5.1.3.3 is mentioned which factors were identified and what their propositional effect appears to be.

Notable is the identified distinction between two different "methods" of standards adoption, (1) the adoption of a single standard and (2) the adoption of a combination of standards for sub-aspects of the product. This distinction was used as an extra dimension of comparison and the presence of certain factors appeared to differ between the two and in the instance of the factors of external support, complexity and normative pressure, the distinction between the two methods appears to have a potential moderating effect. Furthermore, four "new" factors were formulated by thematically codifying the interview transcripts: awareness/prior knowledge, trust in the evolution of the standard, processual characteristics, and costs. These factors are not necessarily parsimonious but are purely recurring themes among the interviews conducted in this research.

5.4.2 – Practical contribution

The practical contribution of this research was to improve the understanding of de jure standards adoption by high-tech start-ups by the entrepreneurs themselves, by the Dutch standards organization and policy makers.

Previous ISO standards adoption studies identified factors for their respective scopes, but with this research a first exploration was conducted into the relevant factors specifically affecting high-tech start-ups. Amongst the results, evidence was found that certain factors appear to affect the adoption by high-tech start-ups that differs from the results of studies such as that of (Hashem & Tann, 2007). Notable is the different "method" of standards adoption and the possibility that this difference appears to have a moderating effect on certain factors. As this research aims to be a first exploration into this specific scope, it therefore contributes as a foundation on which further, for example quantitative, research can be conducted, for example into the effect of the discovered different methods of standards adoption.

Especially for start-ups, who logically have the propensity to have to quickly grow and do not address standards or do so with little resources, this research aims to aid them in their attitude formation and evaluation of standards and possibly help them eliminate uncertainty and/or formulate better standards' adoption strategies.

For the Dutch standards organization and policy makers as well, this research contributes towards the generation of a greater knowledge base as it shows that there appear to be multiple new factors that are relevant. This new information could be used to direct validation investigations into possible strategies for the Dutch standards organization or could be used as a new direction of inquiry by policy makers to potentially adapt their policies.

6. Conclusion

The goal of this research was to explore a new and specific scope within the field of standards' adoption, for which there is minimal literature, namely the scope of high-tech start-ups. This question was formulated as such:

What factors affect de jure standards adoption amongst high-tech start-ups in the Netherlands and are these factors possible to influence by the Dutch standards organization?

With the sub-research questions formulated as follows:

Sub-Research Question #1: *What factors affect de jure standards adoption by Dutch high-tech start-ups, according to scientific literature?*

Sub-Research Question #2: *What factors that affect de jure standards adoption by Dutch high-tech start-ups do Dutch high-tech start-ups themselves identify?*

Sub-Research Question #3: *What factors that affect de jure standards adoption by Dutch high-tech start-ups do Dutch standards organization experts identify?*

Sub-Research Question #4: *Is it possible for the Dutch standards organization to influence the factors affecting de jure standards adoption by Dutch high-tech start-ups and, if so, how?*

To answer sub-research question 1, an extensive literature review was conducted, gathering relevant de jure standards' adoption studies and contextually combining the major recurring applied theories and frameworks to formulate a coherent list of factors affecting de jure standards' adoption, to be used as a basis for the subsequent research steps. Theories used in this list consisted of the DOI of Rogers, network economic factors from Katz & Shapiro and Farrell & Saloner and the neo-institutional theory of Meyer & Rowan and DiMaggio & Powell. Together with the TOE framework and its reformulation by Hashem & Tann, the factors were combined where they overlapped and thus arrived at a coherent list of factors. This consisted of 14 factors, that can be seen in the overview of section 4.1.

To answer sub-research question 2 and 3, semi-structured explorative interviews were conducted with 5 high-tech start-up co-founders (and board members), and a NEN official. The interview transcripts were codified and (implicitly and/or explicitly) identified factors were collected along with the mentioned effect they had on the de jure standards adoption of the start-up. The factors identified were cross-referenced with the list originating from the literature and factors not mentioned were axially (thematically) codified and formulated as new propositional factors. These new factors are: (1) awareness/prior knowledge, (2) processual characteristics, (3) trust in the evolution of the standard and (4) costs. The codified transcripts were then again analyzed to determine which cases identified these four new factors and their respective effects. The factors that were not identified were removed from the total list, which then consisted of identified literature-backed factors and identified new propositional factors, which can be seen in section 4.2.11.

Thirdly and finally, to determine which factors are identified by industry experts as possible to influence by the Dutch standardization authority, a 2nd round of semi-structured explorative

interviews was conducted with the three industry experts to determine which factors they identified that could be influenced and how. Four factors were identified as possible to influence, namely coercive pressure, awareness/prior knowledge, trust in the evolution of the standard and costs. This can be seen in section 5.1.3.1 and 5.1.3.2.

7. Reflection

In this chapter, I reflect on this conducted research, what my experience was, and I reflect on the Management of Technology study program at the TU Delft.

7.1 – Reflection on this research

In the first discussion sessions with my supervisor, Dr. Geerten van de Kaa, an initial dynamic I wanted to research was formulated. This topic was a very complex one however and halfway through the project the decision was made to change the subject of the research. In the first few weeks however, my knowledge about standards grew, having started from nearly nothing. Standardization is a very complex topic and I found it difficult to wrap my head around the different relations, processes and theories at first, but further on during this research it became much clearer. It was evident that little research has been done concerning standardization and high-tech start-ups and, being a TU Delft student and the TU Delft being a university “crowded” by innovation and entrepreneurship, I had to contribute there.

The process of this research was what you would call a pressure-cooker, having due deliverables every two weeks, but this pressure-cooker aspect was intentional. The high pressure really helped with pushing yourself to the limit and better understanding the very complex dynamic that is standardization.

The feedback sessions with my thesis-circle colleagues and my supervisor were as well of great help in formulating this research and understanding the steps that needed be taken. The process of conducting the interviews was one that was very tiresome, as start-ups often do not have the time or resources to spare, and this resulted in a very little response rate. So instead of a quantitative one I decided to switch over to a qualitative one and this proved to be a great choice, not only for the research but also for my own knowledge. In the interviews the co-founders shared their start-up experiences which I found very inspiring.

This research report was a very stressful one but also a very enjoyable one, especially when you realize how much you have learned during and after the process and due to the great interaction with high-tech start-ups.

7.2 – Reflection on Management of Technology curriculum

The study program Management of Technology concerns the business and management aspect of innovation, with topics such as entrepreneurship and strategy in focus. This research report suits this description as it studies the dynamic between entrepreneurs, innovation and standardization. Not only will this report help entrepreneurs understand standardization and its aspects better but through it they can also better understand the importance of standardization and the tremendous role it plays in Dutch society.

As many courses are set around entrepreneurship and strategy, the Management of Technology curriculum has a good fit with this research. The first confrontation with standardization was given by my supervisor, Dr. Geerten van de Kaa, in the course Technology, Strategy and Entrepreneurship, where my second supervisor, Dr. ing. Victor Scholten covered the entrepreneurship aspect. Other courses related to this research are

Research Methods, Preparation for Master Thesis and the other entrepreneurship courses such as Emerging Breakthrough Technologies.

I found the Management of Technology curriculum a good mix of different aspects relating to innovation, management, strategy and entrepreneurship, but if I would change something, I would add a couple of hard skills to the mix such as a more advanced finance course and/or a course containing programming or machine learning/A.I.

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Appendix A – 1st Round of semi-structured interviews: Codified data

The transcripts were codified to identify which factors the interviewees mentioned and the effect the factor had on the adoption of the standard. The data has been split into “single standards adoption” and “combination of standards adoption”. Afterwards, factors that were mentioned that were not in the literature-backed list were collected and axially codified. Section A.1 addresses the identification of the factors in the literature-backed list and the relation thereof with adoption. Section A.2 addresses the axial codification of the factors not mentioned in the literature-backed list, the identification thereof by the interviewees and the relation thereof with adoption.

A.1 – Identified factors included in literature-backed list

The factors mentioned, implicitly and/or explicitly, in statements from the interview transcripts are listed and categorized below. The symbol next to the name of the factor (“(+)” for positive, “(-)” for negative) is the effect of the factor on the adoption according to the propositions in section 4.2. If the factor was not mentioned, “NA” (for Not Applicable) will be placed after the resp. factor.

A.1.1 – Case 1

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “So we started (the company) two years ago, an offshore floating solar company, technology development and with that technology we also develop our own projects as much as possible and standardization will play an important role there too, in the end, because we do not want to change everything drastically for every single project, so we want to move towards a form of mass production as much as possible, because we think that we can also remove the costs from the chain. So, standardization is going to be important to us.”
 - b. “So, I have to achieve, achieve economies of scale and thus be able to show the customer that we also have a very reliable product.”
 - c. “A second is that customers like it, because in fact customers don't like innovation either.”
2. Perceived compatibility: (+)
 - a. “That's always nice, so there isn't a lot of standardization imposed from the outside, other than that you have to land with 66kV or those kinds of requirements, but that's what it's all about: the cables and the inverters and transformers you use.”
3. Perceived complexity: (-)
 - a. “That's always nice, so there isn't a lot of standardization imposed from the outside, other than that you have to land with 66kV or those kinds of requirements, but that's what it's all about: the cables and the inverters and transformers you use.”
4. Perceived observability: NA
5. Competitive pressure: NA

6. Environmental uncertainty: (+)
 - a. "It is exciting enough that we come up with something new, which also floats at sea. Really switching, platforms don't, hey, that's it, hey, that's the next level, so those are, those are for us, yes, that does encourage us to pursue those kinds of things."
7. Mimetic pressure: NA
8. Coercive pressure: (+)
 - a. "Well, we must also be able to insure such a platform and the insurer also sets all kinds of requirements for safety and the expected, expected behavior of the system in order to get it insured and to get it certified."
 - b. "Yes, motivators for this are the bankability, so getting insured and being able to finance that system and banks don't like new technologies at all, they think it's all just exciting and scary, so the more of those stickers there are from the TUs and the NENs of this world, the more pleasant they find it."
 - c. "A second is that customers like it, because in fact customers don't like innovation either. But hey, they want to be sure that what they buy, that it will be there for 30 years and that it also functions, so the more of those, the more of those stickers there are, the better."
9. External support: NA
10. Normative pressure: (+)
 - a. "Yes, but I think it goes further than that, because standardization is also mentioned, you are talking about NEN, so our installation was recently NEN1010 certified, so we would also like to have some kind of approval for that, so to speak."

Concerning combination of standards adoption:

1. Perceived relative advantage: (+)
 - a. "But we are actually already preparing the process and setting it up with BV, in order to eventually get (the product) certified so that it can also float at sea."
 - b. "But what I said a little bit, what we foresee a little bit, but again, you should really talk to (my colleagues) about that, what we kind of foresee is that we get a kind of type approval for the technology, if a Fiat has one of its models, it gets a type approval and then they're allowed to build a million of them."
2. Perceived compatibility: (+)
 - a. "Yes, Bureau Veritas has certified our floating system and that has been more of a consultation model, because there are no standards for offshore floating solar, no regulations for offshore floating solar."
 - b. "With Bureau Veritas we are much more of a yeah, they have drawn much more from existing regulations for offshore wind, for example, and have consulted with us about how, how do we look at it, how have we safeguarded certain things and actually we have, we have also received an approval in principal, because there is no floating solar regulation, specific floating solar regulation, but here we are working much more with such a certification authority to actually do a project-specific and technology-specific check if it is solid and durable."
3. Perceived complexity: (-)
 - a. "Well so in, we've got it all, we haven't frozen anything yet but everything we do, we do in light of future standardization."
4. Perceived observability: NA
5. Competitive pressure: NA

6. Environmental uncertainty: (+)
 - a. “But in the design we are thinking that the thing should be able to be assembled, so to speak, on a meadow on the coast, so we hold back, and that it should fit in a container, so we keep in the design cycle, standardization requirements are already explicitly taken into account, which will apply, so, it must be portable by a few people, it must fit in a container, it must be manufacturable. Well so in, we've got it all, we haven't frozen anything yet but everything we do, we do in light of future standardization.”
7. Mimetic pressure: NA
8. Coercive pressure: (+)
 - a. “We will have to work on regulations, so we are busy working on that too, but in principle we supply a floating installation and BV is perfectly able to assess whether that floating installation can meet the requirements during the intended lifetime and purpose, so we get it certified, only it is yeah, establishing an industry-wide standard in this area.”
 - b. “Well, we just did the tank tests, they look good, those results have of course been shared with the certification authorities.”
 - c. “Not every Fiat is, not every new Fiat is certified, we want that a little bit and in the end, something specific will also be needed, because then there has to be an anchor arrangement, it has to be anchored down.”
9. External support: (+)
 - a. “Yes, Bureau Veritas has certified our floating system and that has been more of a consultation model, because there are no standards for offshore floating solar, no regulations for offshore floating solar.”
 - b. “Well, that's what we're dealing with, now DNV is also working on that, for example, but so is BV.”
 - c. “We will have to work on regulations, so we are busy working on that too, but in principle we supply a floating installation and BV is perfectly able to assess whether that floating installation can meet the requirements during the intended lifetime and purpose, so we get it certified, only it is yeah, establishing an industry-wide standard in this area.”
 - d. “No, it didn't take that long, and it wasn't such a tiring process, to be honest coincidentally, we recorded a video for BV earlier this week, in which we look back on that collaboration with pleasure.”
 - e. “Well after that we will of course continue to work with BV.”
10. Normative pressure: (+)
 - a. “We will have to work on regulations, so we are busy working on that too, but in principle we supply a floating installation and BV is perfectly able to assess whether that floating installation can meet the requirements during the intended lifetime and purpose, so we get it certified, only it is yeah, establishing an industry-wide standard in this area.”

A.1.2 – Case 2

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “But two, yes, of course we get more and more from customers and from insurers, from customers and from firefighters, we were asked: what safety standards do you as a battery meet and how are we going to test that?”
2. Perceived compatibility: (+)

- a. "So I thought well, that will also apply to a battery system."
 - b. "Yes. The NEN1010 is of course a way of avoiding that low-voltage directive, showing that you have applied it for electrical installations, but purely for battery systems that does not apply entirely one-to-one."
3. Perceived complexity: NA
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: (+)
 - a. "And they looked with us at: yes, what requirements should you meet and do you meet them or not? Or what would you have to do to comply?"
 - b. "Well, what I found out is that there are, look at the rules of the European internal market, those are simply the CE directives or the European directives and there are also regulations, you have to somehow comply, only there are no standards yet to demonstrate that you, for example, comply with a low-voltage directive with a battery system."
 - c. "Until those are there, yes, if they don't exist, you can't meet them. But that is why you also have to update something regularly, so we are now also working on an update of that self-declaration, to look at: yes, what are the standards that are there now?"
 - d. "It's not there yet and I've seen a draft of it, but yes, I can hardly say: I fully comply with that, because only when it is definitively published, then you know what it contains."
 - e. "Yes, yes, so I have many conversations with insurers, but they are actually very interested in what measures we take and not so much in the exact standards or certifications, but they are especially very curious about: how have you organized that security? And that's also because they don't have anything to compare it with. They always ask: do you connect it in accordance with NEN1010? Then we say yes, we connect in accordance with NEN1010."
7. Mimetic pressure: NA
8. Coercive pressure: (+)
 - a. "You must comply with the rules of the European internal market."
 - b. "But two, yes, of course we get more and more from customers and from insurers, from customers and from firefighters, we were asked: what safety standards do you as a battery meet and how are we going to test that?"
 - c. "Actually, simply because otherwise you are not allowed to put your product on the European market."
 - d. "Yes, just to add a little bit, but that's okay. I now see the biggest hurdle with us, is with insurers. It is no longer even with the fire brigade or with building owners, but purely with insurers."
9. External support: (+)
 - a. "The individual parts that we use are, in principle, all allowed on the European market, but the assembly, yes, I have to find out whether it works that way or not, so I put in quite a lot of time and must have been a given, also obtained some advice together with DNV, I don't know if you know that, that large consultancy firm, among other things, in the field of standardization. And they looked with us at: yes, what requirements should you meet and do you meet them or not? Or what would you have to do to comply?"
 - b. "Yes, Bureau Veritas is a different club, but actually the way I see it, now we are going to revise our CE self-declaration, for example, and then we will also have some tests carried..."

10. Normative pressure: (+)

- a. "What standardization is actually available to test our design and what we do?"

Concerning combination of standards adoption:

1. Perceived relative advantage: (+)

- a. "And then I also very quickly found out that there is just very little available for this subject, for energy storage systems and so the goals were multiple: one, get them approved in order to be able to sell on the European internal market."

2. Perceived compatibility: (+)

- a. "Well, we will of course, yet we show it a bit that way, but there is not one standard of which you say, if you meet that, one standard, then you are fine anyway, no harmonized standard I'm talking about."
- b. "Anyway, nobody asks about that, you can't, say, something that lies in the future, which you don't know yet will become, you can't test that yet, so to speak."
- c. "Or if those standards aren't there, as in the case of battery systems, this is how I fill that in."
- d. "The individual parts that we use are, in principle, all allowed on the European market, but the assembly, yes, I have to find out whether it works that way or not, so I put in quite a lot of time and must have been a given, also obtained some advice together with DNV, I don't know if you know that, that large consultancy firm, among other things, in the field of standardization. And they looked with us at: yes, what requirements should you meet and do you meet them or not? Or what would you have to do to comply?"

3. Perceived complexity: NA

4. Perceived observability: NA

5. Competitive pressure: NA

6. Environmental uncertainty: (+)

- a. "And then I also very quickly found out that there is just very little available for this subject, for energy storage systems and so the goals were multiple: one, get them approved in order to be able to sell on the European internal market."
- b. "Anyway, nobody asks about that, you can't, say, something that lies in the future, which you don't know yet will become, you can't test that yet, so to speak."

7. Mimetic pressure: NA

8. Coercive pressure: (+)

- a. "...one, get them approved in order to be able to sell on the European internal market."
- b. "You must comply with the rules of the European internal market."
- c. "Well, what I found out is that there are, look at the rules of the European internal market, those are simply the CE directives or the European directives and there are also regulations, you have to somehow comply..."

9. External support: (+)

- a. "...also obtained some advice together with DNV, I don't know if you know that, that large consultancy firm, among other things, in the field of standardization."

10. Normative pressure: (+)

- a. "Look, we as, I think, as a company and as a person just have a responsibility to do things, to do things as well as possible."

A.1.3 – Case 3

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “Yes, so also just trust with customers?”
 - b. “It has undoubtedly helped in a lower premium.”
2. Perceived compatibility: (+)
 - a. “Yes, yes, a risk analysis, I think that battery from back then.”
 - b. “For example, we have talked a lot with the DNV GLs and so on in the world, and ministries, about standards regarding mobile batteries...”
3. Perceived complexity: NA
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: (+)
 - a. “Yes, in terms of software, we have different standards for that. There is of course the way in which we develop the software, we follow standards in that, so you are talking about cybersecurity standards about how do you store things, encrypted or not, then you are talking about: Who can access what data within the company, but also outside the company?”
7. Mimetic pressure: (+)
 - a. “In what ways do you organize your software front-end, back-end and data combinations? But there we just follow the best practices of the software industry and we have, for example, a software architect who is continuously double-checking, securing.”
8. Coercive pressure: (+)
 - a. “So that a ship could use that battery as an energy source, but in its construction, you have to meet all kinds of standards, because if it is on a ship, then it must also come to a ship well, then you have UN38.3, a transport standard, which say a few things about what may and may not happen during road transport, and then you have the standards on board the ship. Those are even stricter, because if a battery catches fire on the road, you run away, if you catch fire on a ship, you don't just walk away.”
 - b. “As far as hardware is concerned, it is mainly regulations, because otherwise you are simply not allowed on board or on the road, if you do, you will get fines.”
9. External support: (+)
 - a. “So, for example, that container was almost ready then, produced, and then the certification company came by, certification company, I think that was Register Holland...”
 - b. “Yes, yes, a risk analysis, I think that battery from back then.”
 - c. “Spent a little, but not a lot of time. For example, we have talked a lot with the DNV GLs and so on in the world, and ministries, about standards regarding mobile batteries...”
10. Normative pressure: NA

Concerning combination of standards adoption:

1. Perceived relative advantage: NA
2. Perceived compatibility: NA
3. Perceived complexity: NA
4. Perceived observability: NA

5. Competitive pressure: NA
6. Environmental uncertainty: NA
7. Mimetic pressure: NA
8. Coercive pressure: NA
9. External support: NA
10. Normative pressure: NA

A.1.4 – Case 4

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “So, we were designing completely from a standard and, the great example in my life is IKEA, if you enter that store and you have that crooked wrench, you can take the whole store apart, it was standardized.”
2. Perceived compatibility: (+)
 - a. “Now, that is quite difficult for (the company), but well, that is difficult for all housing unit builders, and that is why the requirements of such a housing guarantee are quite strict, but we will make it, we are with (the company) with that in process. We just want that if you are building something and you go bankrupt that it can be completed for the customer.”
 - b. “That in itself is not that difficult. Look, you have to meet certain requirements, period. If you're in a terrible hurry, that's great, but you can't drive faster than 100 km per hour! You always have technical challenges, but we had a pretty nice team for that, it was only with those installations that things went wrong because nothing had ever been tested.”
3. Perceived complexity: (-)
 - a. “In residential construction, standards are still rarely used, unlike in the car industry, for example! A lot of mistakes are still made.”
 - b. “Now, that is quite difficult for (the company), but well, that is difficult for all housing unit builders, and that is why the requirements of such a housing guarantee are quite strict, but we will make it, we are with (the company) with that in process. We just want that if you are building something and you go bankrupt that it can be completed for the customer.”
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: NA
7. Mimetic pressure: (+)
 - a. “In residential construction, standards are still rarely used, unlike in the car industry, for example! A lot of mistakes are still made.”
8. Coercive pressure: (+)
 - a. “But what about legal regulations? Yes, we absolutely adhered to that.”
 - b. “Yes, you are obliged to. We also happen to be working on (the company) right now to get to home security and you are required to have car insurance while building. Such a housing guarantee means that if the contractor goes bankrupt during construction, that group takes over, and as a contractor you have to comply with certain requirements.”
 - c. “Now, that is quite difficult for (the company), but well, that is difficult for all housing unit builders, and that is why the requirements of such a housing guarantee are quite strict, but we will make it, we are with (the company) with that

in process. We just want that if you are building something and you go bankrupt that it can be completed for the customer.”

9. External support: NA

10. Normative pressure: (+)

- a. “What we also did or tried to incorporate in it is, in addition to the standards, also a bit of flexibility.”
- b. “Yeah, okay. So if I understand correctly to have that flexibility in construction, that you can move things in a bit of a modular way within your house, so you're going to introduce certain features, so with those electrics, I can move those outlets and to do that. you then need those NEN/ISO standards and then you can actually go ahead.”
- c. “Yes. You can do anything if you stay within the law.”

Concerning combination of standards adoption:

1. Perceived relative advantage: NA
2. Perceived compatibility: NA
3. Perceived complexity: NA
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: NA
7. Mimetic pressure: NA
8. Coercive pressure: NA
9. External support: NA
10. Normative pressure: NA

A.1.5 – Case 5

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “Absolutely, in order to be able to sell things you have to be able to demonstrate that things are safe, good and such. In addition, to sell products, especially in an industrial market, you are simply expected to comply with the Machinery Directive, which is simply a regulation of CE. Everything you put on the market in Europe has to be CE, so you have to, as the person who puts the product on the market, you are responsible for finding out which regulations you would have to comply with and from that which standards you would can test.”
 - b. “But the most important thing in the sales process is to convince people that it is good and safe and to give people tools to compare it.”
 - c. “Yes, I mainly think in being able to convince people that it's all right, because what you come up with yourself is often not enough...”
 - d. “If he doesn't get it insured, he won't buy it.”
2. Perceived compatibility: (+)
 - a. “In addition, to sell products, especially in an industrial market, you are simply expected to comply with the Machinery Directive, which is simply a regulation of CE. Everything you put on the market in Europe has to be CE, so you have to, as the person who puts the product on the market, you are responsible for finding out which regulations you would have to comply with and from that which standards you would can test.”
 - b. “The harmonized ones are mandatory...”

- c. “Yes, I think it could have been faster by a factor of 1.2 if these kinds of things had been defined.”
- 3. Perceived complexity: (-)
 - a. “Yes, a product, which can simply be more dangerous. So if you just do a small risk analysis then you just see with batteries, they can burn quite well if something goes wrong and that can be a danger to people and simply the danger to people, however small the chance, there is potentially a significant consequence and that ensures that parties and customers sit down harder on this and that is then made more difficult in our case...”
 - b. “They are big enough to take the majority of the tests themselves. Liability, I think it comes down to that and we are too small, we can absolutely do a number of tests but we do that externally because we... people don't assume that if it comes from a smaller party it's necessarily good and we couldn't bear that liability either.”
 - c. “...but in terms of manageability it is sometimes just a monstrosity.”
- 4. Perceived observability: NA
- 5. Competitive pressure: NA
- 6. Environmental uncertainty: (+)
 - a. “Yes, I think it could have been faster by a factor of 1.2 if these kinds of things had been defined. And they are still not in many areas, which is also why I can still contribute to standards. It's not that the rest in our market don't experience it.”
 - b. “Because of your product, there are all kinds of rules for that, all risk analyzes that you have to comply with, we have to keep them for ten years and we have a party like DEKRA screen and test our product completely.”
 - c. “You have to know how many of certain substances are put on the market, so that you can also enforce something related to recycling, to take it off the market again.”
 - d. “But suppose you want to give something the CE mark in Europe and something has not yet been adopted, you can still take the European one, it just has not been harmonized yet.”
- 7. Mimetic pressure: NA
- 8. Coercive pressure: (+)
 - a. “The harmonized ones are mandatory...”
 - b. “Yes, look, a few are mandatory, otherwise you are not allowed to transport something or you are not allowed to position something in a certain market, that's fine, that's easy, many parties can check that themselves, certainly with regard to CE, completely right to do it yourself.”
- 9. External support: (+)
 - a. “Yes, it happens to be accredited, but we also work with TÜV, or yes a DNV or a Lloyds or a Bureau Veritas, those are good names.”
 - b. “You also have to identify yourself what is mandatory, which makes it all the more difficult, because that is not possible.”
 - c. “They are big enough to take the majority of the tests themselves. Liability, I think it comes down to that and we are too small, we can absolutely do a number of tests but we do that externally because we... people don't assume that if it comes from a smaller party it's necessarily good and we couldn't bear that liability either.”
 - d. “That's not too bad to what extent we are insured there, but actually having an accredited party sign off is a kind of insurance. Actually, you pay such a party to put their name on there.”

- e. “Because of your product, there are all kinds of rules for that, all risk analyzes that you have to comply with, we have to keep them for ten years and we have a party like DEKRA screen and test our product completely.”
10. Normative pressure: (+)
- a. “It is for product safety, consumer or company protection, being able to compare the performance of products fairly. That is a lot more important, at least in my opinion, when it comes to safety and the function of safety, then you have to start comparing standards with each other, otherwise it is simply not possible to be objective and a consumer or other company, you have to assume that they have too little knowledge to check whether a product is somewhat safe or satisfactory or okay. So, it is very useful to have a guideline in standards to check with.”

Concerning combination of standards adoption:

1. Perceived relative advantage: (+)
 - a. “So it's nice that we have a Dutch guideline. But we have tried to interfere with that a bit, because for a number of customers, most customers, they don't know either, so they shift it, they hope that we can answer that. So to accommodate them, we delve into that more and we want to interfere more, but...”
2. Perceived compatibility: (+)
 - a. “We have followed a trajectory at DEKRA, but that is an accredited testing house, to identify what is relevant to us.”
3. Perceived complexity: NA
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: (+)
 - a. “...but there are many more that will probably be harmonized someday and you have to demonstrate that the product is safe.”
 - b. “We have followed a trajectory at DEKRA, but that is an accredited testing house, to identify what is relevant to us.”
7. Mimetic pressure: (+)
 - a. “Other companies then have to keep something so that an accredited party can test it.”
8. Coercive pressure: (+)
 - a. “...but there are many more that will probably be harmonized someday and you have to demonstrate that the product is safe.”
9. External support: (+)
 - a. “Then you have parties such as a DNV and a Bureau Veritas and a Lloyds, which are actually self-measurement organizations.”
 - b. “Yes, those kinds of parties can certainly give good advice and we have not done that with these specific parties.”
 - c. “We have followed a trajectory at DEKRA, but that is an accredited testing house, to identify what is relevant to us. So, we are now working with a party that plays on a global stage, so there is now a look at compliance and product compliance, engineers are available to analyze this.”
 - d. “So yes, involving a DNV, now, in the short term, is no longer logical for us, but indeed, at a certain point you are looking for someone who wants to give advice and that is difficult.”
10. Normative pressure: NA

A.1.6 – Case 6

Concerning single standards adoption:

1. Perceived relative advantage: (+)
 - a. “In addition, you also have standards that you can meet, which is not mandatory, but it is useful because you can show that you meet a standard towards customers, then that creates trust. It is a piece of certainty, a piece of transparency too.”
 - b. “Well that is very important, also for your customers of course, and then you have additional standards and that can be anything, there are 34,000 standards and the good majority of them are not mandatory but useful to comply with.”
 - c. “...but I also think that it depends on demonstrating safety, so you have to do those tests anyway, otherwise it won't be sold.”
2. Perceived compatibility: (+)
 - a. “Yes, okay, well that is mainly from my hand, with several others of course, I also have to say that I am an innovation broker by the way, so I also receive questions from startups such as: “Can you help me further?”, assuming a particular finding or initiative concept.”
 - b. “The point with a really new and innovative concept is, of course, that the existing standards can't completely cover it and you can see that in the question, because they cannot find the right standard. Then we will indeed check whether they have searched properly in NEN-connect, a database, you probably know NEN-connect, and then we will, in any case, look at which standards come close, which standards committee is relevant and what international level on that subject. It may well be that a new standard is being developed, you will not find it in NEN-connect, you will not see it directly on our website, but we do have access to it. That can be a norm at ISO level, or an IC or at a CEN-CENELEC.”
 - c. “Yes, because we are actually the gateway to the international standardization web. Not always necessary, by the way, because I also have an example of a startup ROCSYS, which is also an interesting one to talk to, they were also at the Green Village, then I also got a question like: what standards are does this apply to our invention?”
 - d. “Yes, that can be multiple goals, but often it's just compliance, so look at: which standards must we meet with our device, with our product? And what I always say, and that is also the core message of the NENovation Funnel, is that the moment you notice that the existing standards can't cover it completely and you have interesting, distinctive elements in your invention on which you can formulate new requirements, then it becomes interesting to set your own standard.”
3. Perceived complexity: (-)
 - a. “...that actually interprets a European standard differently than other European countries. This concerns the NEN1010 committee, which concerns the installation sector. The NEN1010, that is for installers, that standard is used a lot. That committee, which is against that plug-and-play solar panel, which incidentally focuses directly on the consumer, and also complies as a consumer product, so they actually just meet the standard for consumer products, but when the installation company has such a thing is going to use in his work, then the installer no longer complies with NEN1010. There are arguments behind this, technical arguments, safety arguments especially, so that NEN1010 committee, that Dutch committee, has major doubts about the safety of the product, the moment you, for example, I know a lot, connect 10 of those things in a row on an existing power group, everything can burn out with a fire as a result, and if it is only a very small chance then you have to take that seriously into account.”

- b. “Well, they are now mainly active in European countries where the European framework standard is explained in a different way, where it is allowed.”
 - c. “...what is very important is that the greatest risk is with the consumer, and consumer behavior is very decisive for things that go wrong and so, whatever they put on the box, three solar panels on 1 group, but that NEN1010 committee says that if an idiot puts 10 in a row, you generate great risks, that's what it's about. There are still a number of technical aspects that they are concerned with, also related to fire risk, by the way.”
- 4. Perceived observability: NA
- 5. Competitive pressure: NA
- 6. Environmental uncertainty: (+)
 - a. “...that actually interprets a European standard differently than other European countries. This concerns the NEN1010 committee, which concerns the installation sector. The NEN1010, that is for installers, that standard is used a lot. That committee, which is against that plug-and-play solar panel, which incidentally focuses directly on the consumer, and also complies as a consumer product, so they actually just meet the standard for consumer products, but when the installation company has such a thing is going to use in his work, then the installer no longer complies with NEN1010. There are arguments behind this, technical arguments, safety arguments especially, so that NEN1010 committee, that Dutch committee, has major doubts about the safety of the product, the moment you, for example, I know a lot, connect 10 of those things in a row on an existing power group, everything can burn out with a fire as a result, and if it is only a very small chance then you have to take that seriously into account.”
 - b. “...what is very important is that the greatest risk is with the consumer, and consumer behavior is very decisive for things that go wrong and so, whatever they put on the box, three solar panels on 1 group, but that NEN1010 committee says that if an idiot puts 10 in a row, you generate great risks, that's what it's about. There are still a number of technical aspects that they are concerned with, also related to fire risk, by the way.”
- 7. Mimetic pressure: NA
- 8. Coercive pressure: (+)
 - a. “Yes, that can be multiple goals, but often it's just compliance, so look at: which standards must we meet with our device, with our product?”
 - b. “There are several goals to comply with standards, one of which is that it can be imposed by legislation, that it is the implementation of directives, where, for example, the Machinery Directive is a very relevant one, and for electrical appliances you naturally have to deal with the low voltage directive for example, well those are standards that you have to comply with.”
 - c. “Yes, look, those mandatory guidelines often relate to safety.”
 - d. “...that actually interprets a European standard differently than other European countries. This concerns the NEN1010 committee, which concerns the installation sector. The NEN1010, that is for installers, that standard is used a lot. That committee, which is against that plug-and-play solar panel, which incidentally focuses directly on the consumer, and also complies as a consumer product, so they actually just meet the standard for consumer products, but when the installation company has such a thing is going to use in his work, then the installer no longer complies with NEN1010. There are arguments behind this, technical arguments, safety arguments especially, so that NEN1010 committee, that Dutch committee, has major doubts about the safety of the product, the moment you, for

example, I know a lot, connect 10 of those things in a row on an existing power group, everything can burn out with a fire as a result, and if it is only a very small chance then you have to take that seriously into account.”

9. External support: (+)

- a. “Yes, okay, well that is mainly from my hand, with several others of course, I also have to say that I am an innovation broker by the way, so I also receive questions from startups such as: “Can you help me further?”, assuming a particular finding or initiative concept.”
- b. “The point with a really new and innovative concept is, of course, that the existing standards can't completely cover it and you can see that in the question, because they cannot find the right standard. Then we will indeed check whether they have searched properly in NEN-connect, a database, you probably know NEN-connect, and then we will, in any case, look at which standards come close, which standards committee is relevant and what international level on that subject. It may well be that a new standard is being developed, you will not find it in NEN-connect, you will not see it directly on our website, but we do have access to it.”
- c. “Yes, because we are actually the gateway to the international standardization web. Not always necessary, by the way, because I also have an example of a startup ROCSYS, which is also an interesting one to talk to, they were also at the Green Village, then I also got a question like: what standards are does this apply to our invention?”
- d. “And what I always say, and that is also the core message of the NENovation Funnel, is that the moment you notice that the existing standards can't cover it completely and you have interesting, distinctive elements in your invention on which you can formulate new requirements, then it becomes interesting to set your own standard.”

10. Normative pressure: (+)

- a. “In addition, you also have standards that you can meet, which is not mandatory, but it is useful because you can show that you meet a standard towards customers, then that creates trust. It is a piece of certainty, a piece of transparency too.”

Concerning combination of standards adoption:

1. Perceived relative advantage: NA

2. Perceived compatibility: (+)

- a. “Yes, there are always parts or yes there are standards that you have to meet, but if you make an electrical device, you already have to meet a number of standards. That is, often that is just the case, whether it is a toy or I don't know what, there are always requirements that you have to meet. So, it is always good to orientate yourself on this with the question: what requirements do I have to meet?”

3. Perceived complexity: NA

4. Perceived observability: NA

5. Competitive pressure: NA

6. Environmental uncertainty: (+)

- a. “So, it is always good to orientate yourself on this with the question: what requirements do I have to meet?”
- b. “There are two routes, one goal can be that you want to be certified, you want to have your product certified, you do that via those notified bodies, and the other route is you say: I also want to influence the development of standards and then you participate in the standards committees and then there are completely different

considerations, that is especially if there are no standards yet, as in the example I just mentioned from ROCSYS, but of which it is clear that if at a time a standard is that it is very favorable for you.”

7. Mimetic pressure: NA
8. Coercive pressure: (+)
 - a. “Yes, there are always parts or yes there are standards that you have to meet, but if you make an electrical device, you already have to meet a number of standards. That is, often that is just the case, whether it is a toy or I don't know what, there are always requirements that you have to meet.”
 - b. “If you do record, and it is clearly stated, that you put a maximum of two or three in an existing group, then as a manufacturer you have simply complied with the safety regulations.”
9. External support: (+)
 - a. “...all startups in fact do that, and I say that to them: "go to a notified body", such an organization that indeed is like this, they can arrange a certification for you, because they have the overview, they know exactly what tests are needed and they can also help you the fastest when you are ready for it.”
10. Normative pressure: NA

A.2 – Axial codification of factors not mentioned in literature-backed list, identification thereof and effect determination

Other factors mentioned were thematically analyzed and four themes recurred: (1) awareness/prior knowledge, (2) processual characteristics, (3) trust in the evolution of the standard and (4) costs. The “other” factors were then codified again and categorized within these themes. This resulted in four new propositional factors (with the same names). The statements referring to these factors are listed per factor, below. The effect the factor has on adoption (according to the definitions formulated in Table 23) is given per case, stated next to the name of the case (“(+)” for positive, “(-)” for negative), if there is no mention of the factor, “NA” (for “Not applicable”) is put instead. The statements are as well underlined in the transcripts. Case 6 (the NEN official) did not mention processual characteristics or costs in the interview but did mention them in Case 8 (the same official). Therefore, the mentioned statements will be included here with Case 6.

A.2.1 – Concerning awareness/prior knowledge:

- **Case 1: (+)**
 - “...one of the aspects we are working on is to map out the regulations...”
 - “Yes, if you do not have those contacts and you do not have the dexterity to deal with them and indeed you do not get it certified, then you do not get financed, you do not get insured and then it is, then you simply have a serious continuity problem.”
 - “Yes, I was not too involved in that myself. The technical side of the organization really does that, so (my colleagues) mainly did that, but the people at Bureau Veritas have known them for a long time.”
 - “They are acquaintances. If you come from the industry, then you know how the infrastructure works. Well, if you're really a fresh new startup and you have one, you have such an idea and you have yet to explore everything. Yes, I can imagine that would be difficult.”

- **Case 2: (+)**
 - “Many people say: that is in the NEN1010, but then they have simply never read it or that was in the version from long ago. I really thought about it: what does it really say? Because there are a lot of things that make people say: yes, you can't put a battery down, but if you really read carefully, it doesn't say that at all. Anyway, that's just how it goes, people who think they know what it says, because they've always been told that and then it turns out to be different in practice. That is also an interesting aspect of standardization that I found out.”
- **Case 3: NA**
- **Case 4: NA**
- **Case 5: (+)**
 - “Totally unclear.”
 - “But it is again that the insurer does not understand it. And in the absence of technicians, knowledge, with different parties or in the absence of defined standards, it is not clear what you have to comply with, or there is actually not something that applies to your product. Then it just becomes a difficult conversation and that sometimes makes it unnavigable, and that is a kind of brake because people don't dare, because yes, we don't have any requirements, we don't know what makes sense, there aren't any.”
 - “That's a bit of a risk as a whole. Especially being able to identify well, just knowing how to find your way in what is relevant or in your scope, that is so unclear, because you just can't immediately, where do you look that up? There is not one place where you can find that.”
 - “No, exactly, but we are also responsible for complying with what we now have to comply with. We always have to comply with what it is, what the state-of-the-art is, that is actually the requirement, but what the state-of-the-art is and what it complies with, you can't even navigate between all the guidelines, because there's not a place where you can do that.”
 - “Well, yes, then there will be a new version of your guideline, which you already did before, for example, then the revision will come like... how you know that revision is there, you just have to but continuously actively looking for it and that is unclear, it would be nice if the European Union had a decent standards database for that, on which you could see which are harmonized, which are mandatory, which are coming but it is extremely unclear.”
- **Case 6: (+)**
 - “Then we will indeed check whether they have searched properly in NEN-connect, a database, you probably know NEN-connect, and then we will, in any case, look at which standards come close, which standards committee is relevant and what international level on that subject. It may well be that a new standard is being developed, you will not find it in NEN-connect, you will not see it directly on our website, but we do have access to it. That can be a norm at ISO level, or an IC or at a CEN-CENELEC.”
 - “Then I said: guys, too bad but that smoke detector has a standard, and an important aspect is free space around the smoke detector, and no heat et cetera, so what you want is not possible according to that existing standard. But it could well be that you develop a new standard where it is technically possible, only then you will enter a very long technical process, which you have to demonstrate, say, that it can operate safely and properly. I usually use it because they were already so far with the whole development and with the

design and that it's just a shame if you don't look at what standards you have to meet at an early stage.”

A.2.2 – Concerning processual characteristics:

- **Case 1: (+)**
 - “Yes, I was not personally involved in that, but NEN just came by and looked at the design and they approved it. So that actually goes very transactional looking, feeling and rattling and seeing that it's good, so to speak.”
 - “No, it didn't take that long, and it wasn't such a tiring process, to be honest. coincidentally, we recorded a video for BV earlier this week, in which we look back on that collaboration with pleasure.”
 - “I think it would have taken a few months. Two months, three months perhaps? They have been on a platform with us.”
- **Case 2: (+)**
 - “Look and that CE, which in principle is on everything, should be on everything, is a self-declaration. So, you just say my product complies with the rules it has to comply with.”
 - “Yes, only in very specific cases, for example, the chainsaw again. Suppose you have made a chainsaw, then you have to have it tested by an external party, or if it's something dangerous, you know, a gas burner or a central heating boiler. If it isn't one of those products, then you can just say yourself: I comply with the rules that apply to it.”
- **Case 3: NA**
- **Case 4: NA**
- **Case 5: (+)**
 - “So you have to maintain something and sometimes you can test things like that internally like the voltage, I can measure that myself so if I want to be with very well calibrated equipment and self-responsible, I can measure the voltage myself and then I can do that but that is generally something for larger companies to do, because they can then be really liable.”
 - “...large parties can afford to make their own technical assessment, test themselves and then also accept liability, take it for a fact that it is good or not...”
 - “Certainly, those are expensive processes, slow processes, that must be the case with a DNV, a DEKRA, all those accredited parties, yes: expensive, slow, stiff.”
 - “Well, that costs us half a year and a lot of money, but that means that if it goes to court, we have done our utmost, demonstrably to have our product safe.”
- **Case 8*: (+)***
 - “Maybe speed too, so what I heard now, for example, but well that's not a standard but a medical guideline, I heard that on the radio, that it takes about two years before you can demonstrate that you can use your clinical research complies with that directive.”
 - “Well, two years, you don't have that as a start-up, time is also an important issue. Incidentally, there are many start-ups that decide to establish themselves in the United States because the procedure is also much faster there.”

- “Time, money, those are always the issues of course. To what extent do you also prevent bottlenecks? If you do not meet everything at that stage, what are the risks later on? Yes, I think that’s basically it.”

A.2.3 – Concerning trust in the evolution of the standard:

- **Case 1: (+)**
 - “Yes, you can see that floating solar installations on inland waterways already exist, but floating solar installations at sea are really still very new, so you can see that one of the aspects we are working on is to map out the regulations and, if possible, even shape it to our liking. That’s always nice, so there isn’t a lot of standardization imposed from the outside, other than that you have to land with 66kV or those kinds of requirements, but that’s what it’s all about: the cables and the inverters and transformers you use. Not so much, it has not so much to do with the technology that we develop and use.”
 - “Well so in, we’ve got it all, we haven’t frozen anything yet but everything we do, we do in light of future standardization.”
- **Case 2: (+)**
 - “So there was a lot that wasn’t there, there was also something that was, but a lot was not, and that’s why I joined at a certain point, I joined, that was not yet a standards committee at the time, but that was a kind of advisory committee who ran for battery systems at the NEN in Delft to see if we could still make something of standardization for the Dutch market and that eventually became a standards committee and then we compiled a standard in two years’ time, an extension of the NEN3140 , I don’t know if you know it, but that is a standard for safe working with electrical installations, and we have actually made an extension to it, that is NEN4288, specifically what additionally applies to battery systems.”
 - “Okay, and then, yeah, what’s the importance of being on such a committee? Yes, I had a perhaps somewhat naive idea of that, I thought well, there are all people who are smart and who have their hearts in the right place and they are going to think together for a while how we can do this as smartly as possible and they all do it unpaid and hey for the greater good, that’s actually a very commercial exercise too, so you pay relatively high for a startup to be able to participate in such a standards committee. That also gives you influence on what is written in the standard. And there are sometimes people in that standard committee from companies, just to ensure that, for example, a certain product of theirs meets that standard, or at least that you can hardly choose another product.”
 - “Of course, they’re sitting there, hey, the people sitting there really have their hearts in the right place, but there are just sometimes people among them, they just want, hey and so did I, I also had certain interests, I was really there because of the interest of (the company), and that interest is certainly safety, but also workability because if we are all going to make it so difficult that it cannot be anymore then yes, then our jobs are done for as well.”
 - “No, you don’t have to. If your product has already been sold, then you don’t have to. And look, you can use standards to demonstrate that you comply, which is an easy way to demonstrate that you comply with certain directives. But it is not necessary, you can also demonstrate it in another way. It just gets

- very difficult. And if you've made a product and there's a new standard coming, yes, then you may need to adjust your product, but not retroactively.“
- “No, so now you see that the standardization for battery systems and for lithium-ion as a material, which is in 90 percent of battery systems, is lagging far behind reality.”
 - **Case 3: (+)**
 - “...but we have never gone through a whole process ourselves, because it just takes too much time and the people we already have in such a club, we thought, well, they can represent this much better than us because they... We are of course very much on the commercial side with our system and rely mainly on technology that is already there.”
 - **Case 4: NA**
 - **Case 5: (+)**
 - “And the evil part is unfortunately that it occasionally goes a bit too far, so that there are certificates that it can really inhibit innovation and innovation development, because it always lags behind. So, everything that is there is not always relevant or that is not entirely applicable or it sets certain requirements that are simply no longer logical to expect due to other technological innovations. So that can really be an inhibitor and figuring out what you have to meet at all, that's just impossible.”
 - “Because it is lagging behind, I expect it to be somewhat decent in five years' time. Now, due to ignorance, even at the government itself, for example at the RDW, other standards are mentioned that are not at all of scope for our products. We make batteries, so they take a battery standard that applies to the mass production of cars, which just really makes no sense, how it is inserted, what is technically expected, thus guarantee nothing at all, if you would expect that in our market. Due to a lack of something specific or due to a lack of ordinary knowledge, because it is very difficult to navigate between what all is relevant. Yes, things are then mentioned and that comes to life and then something that is intended for the mass production car suddenly applies for a lawn mower!”
 - “...we identified a series that we want to comply with in any case, a number of potential things that can be done in the future interesting whether they are actually not intended or should not be connected...”
 - “Especially at such a NEN there are really big parties lobbying to do it according to their taste, and you can see that.”
 - “And then there are some large parties that lobby because they all have products that no longer comply with this. So, it's not just safety. The integrity is never going to be 100 percent on that sort of thing.”
 - “We now have a number of adjacent products, but which fortunately had nothing to do with us, seeing that certain products could by chance continue to be used from a large party that was active worldwide, and that a number of other products were actually no longer allowed, while that is not necessarily right.”
 - “Yes, I am very curious what that will ultimately be, because it is not yet clear and a number of parties are lobbying well, so I am very curious what effect that will have on our products. Something like that can have a negative impact, or positively, but yes, at least never in black and white.”
 - “And yes, for some things yes, some things still have to be performed retroactively. There is always a period behind that, again due to the lobbying

practices of companies. Sometimes certain new requirements are divided, so only when you make an adjustment do you have to meet the state-of-the-art again, or you have two years to fix a part and then four years to fix even a larger part of these new requirements. But yes, that also means for a number of companies that it will be ready by then.”

- **Case 6: (+)**
 - “You can of course introduce such a development as a new work item, and then it will be included in such a standard committee, as an improvement of such an existing standard, as an extension.”
 - “Yes, that can take a long time, but other things can be done faster. We also had a winner of the NENnovation awards at one point, and he made those rice-fiber road signs, they had a problem because the standard with road signs is, which states that the back must be gray, and rice-fiber is white, and for the rest it completely met that standard, in all aspects, just not in that aspect. What they subsequently did in response to that, in that committee, they made that standard material-independent with the determination of a gray area at the back, had no added value at all, but well, they removed that.”

A.2.4 – Concerning costs:

- **Case 1: NA**
- **Case 2: (-)**
 - “...if you want to buy the NEN1010, you have to pay 600 euros.”
 - “...we had a subscription, well such a subscription cost tens of thousands of euros per year and then you can view all the standards, but that's just their revenue model. It is not a quality institution or government organization.”
- **Case 3: NA**
- **Case 4: NA**
- **Case 5: (-)**
 - “...so it is certainly not feasible for every system you make to take it through a certification process. You spend a month developing and building and then you would have to do half a year of testing for 20 times the cost of such a package, where ten such systems are written off because they are tested destructively, while the customer wants to buy just one.”
- **Case 8*: (-)***
 - “Cost may also be an issue.”
 - “Time, money, those are always the issues of course. To what extent do you also prevent bottlenecks? If you do not meet everything at that stage, what are the risks later on? Yes, I think that's basically it.”
 - “Then they can create a free account in NENconnect and then you can search but you cannot download standards. Well, you can, but then you have to pay for the standard.”
 - “Yes, it is actually necessary to be able to see those standards, and they don't all cost money, quite a few are also free. You can see the table of contents, so that you get an idea of what exactly it says. But yes, you sometimes have to be creative, you shouldn't have very high costs.”

Appendix B – 2nd Round of semi-structured interviews: Codified data

The transcripts are codified by means of identifying the mentioning of factors by their definition in section 4.2.6 and are underlined in the transcripts. Then it is determined if the influencing of the factor is mentioned and extracted from the transcripts. These factors can be found below, categorized per case, according to the final overview list of factors from section 4.1. If the factor is not mentioned, “NA” (for Not applicable) will be put aside the resp. factor.

B.1 – Case 7 – Dutch standards organization experts

1. Perceived relative advantage: NA
2. Perceived compatibility: NA
3. Perceived complexity: NA
4. Perceived observability: NA
5. Competitive pressure: NA
6. Environmental uncertainty: NA
7. Mimetic pressure: NA
8. Coercive pressure:
 - a. “And that is a combination, I think, of quality and usability, because it adheres to the quality and therefore it is usable for a certain application. So that is, I think, recognizable and it even goes so far that in the Netherlands or even in Europe, that if you adhere to the standard once, you can sell your product in all the member states within the EU. With this you have achieved market penetration.”
 - b. “I can imagine that if they want financing, the financier will ask them what the product is, and if it complies with the standards. They don’t know, because there aren’t any standards yet, and then they hire a company to find the needles in the haystack to see what the most relevant standards are and then they compile these partly and say “look, we already have this”, hoping that the financier and insurer can be persuaded that it is a solid base.”
9. External support: NA
10. Normative pressure: NA
11. Awareness/Prior knowledge: NA
12. Processual characteristics: NA
13. Trust in evolution of standard:
 - a. “...and that’s where, more often, you see initiatives outside of formal standardization, to give that substance. However, if new parties do this then there is an added disadvantage that the insurer might not accept the standard of these parties if they have not yet been accepted by peers.”
 - b. “Yes, of course there are the formal institutions such as CEN or ISO but there are also others such as IEEE for, for example, Wi-Fi standards and that is a consortium, often they’re consortiums, more for larger companies but startups can of course also partake. But yes, inside ISO it goes very slowly. Sometimes another platform is needed because a new standard needs to be made every two months and it needs to be checked quickly so that everybody can move on. And that’s why

such initiatives have sprouted and some of them, such as IEEE, are now so large, they already have thousands of members, but they can also standardize very quickly, or make decisions. So yeah, eventually people find each other right, they say: “This is what we’re struggling with, we need to agree of a basis, it helps all of us if we have agreements concerning it, because it then enables compatibility, or we know what we have to comply with”. And then you see that this different type of initiatives also come into existence. But for a person starting a new business from scratch...”

- c. “They often also talked about speed.”
- d. “Often times it went: “yeah we would like to quickly have the standard” and at ETSI it could go somewhat faster.”
- e. “ETSI is also a formal standardization organization such as ISO/CEN.”

14. Costs: NA

B.2 – Case 8 – NEN Official

- 1. Perceived relative advantage: NA
- 2. Perceived compatibility: NA
- 3. Perceived complexity: NA
- 4. Perceived observability: NA
- 5. Competitive pressure: NA
- 6. Environmental uncertainty: NA
- 7. Mimetic pressure: NA
- 8. Coercive pressure: NA
- 9. External support: NA
- 10. Normative pressure: NA
- 11. Awareness/Prior knowledge:
 - a. “Education, so that attention is paid to it in education. Or that he got that from his incubator or the location where it is. That can be different sources, it can also be financiers or investors who draw his attention to this or simply ask the question about it.”
 - b. “For example in our database, NENconnect. You can search there. Just like Espacenet, where you can search for patents, you can search for the relevant standards in NENconnect. But then it must be known that NENconnect exists.”
 - c. “NENconnect contains all standards that apply in the Netherlands, so those are national standards, CEN-CENELEC standards, so European.”
 - d. “Yes, then the Netherlands is a very good basis because we adopt all European standards anyway and almost all ISO standards. And in addition, you have the American standards, ASTM for example, which are also all in NENconnect. We also have German standards in NENconnect. Some of it is national standards, but most of it is European standards and International standards.”
 - e. “Two weeks ago I gave a guest lecture at the Rotterdam University of Applied Sciences. And then well, that story is indeed about the world of the organization, so to speak, and pros and cons, et cetera, which we just discussed, but also the search, so an assignment in NENconnect.”

- f. “Well for HBO it is, so you can get in for free on HBO. And at universities, that's where it differs. We have separate agreements with universities, so some do and some don't.”
- g. “Well, these are often students who started with a start-up, so in general they have students who have access.”
- h. “Then they can create a free account in NENconnect and then you can search but you cannot download standards. Well, you can, but then you have to pay for the standard.”
- i. “Yes, it is actually necessary to be able to see those standards, and they don't all cost money, quite a few are also free. You can see the table of contents, so that you get an idea of what exactly it says. But yes, you sometimes have to be creative, you shouldn't have very high costs.”
- j. “That's right, to simply guide startups in their search. Precisely those aspects that you just mentioned help to familiarize yourself with the world of standardization and help you to find relevant standards. Yes, you can do that via a link to NENconnect. I also made a guide for that. It is about thinking about a standardization strategy, when there is no comprehensive standard, you can of course consider developing a standard yourself. We can help you with that.”
- k. “It's about: I have a product on the market and I want to go international, how can I grow internationally, with the help of the organization? That can sometimes be an important instrument, all those kinds of aspects.”

12. Processual characteristics: NA

13. Trust in evolution of standard: NA

14. Costs:

- a. “Well for HBO it is, so you can get in for free on HBO. And at universities, that's where it differs. We have separate agreements with universities, so some do and some don't.”
- b. “Then they can create a free account in NENconnect and then you can search but you cannot download standards. Well, you can, but then you have to pay for the standard.”
- c. “Yes, it is actually necessary to be able to see those standards, and they don't all cost money, quite a few are also free. You can see the table of contents, so that you get an idea of what exactly it says. But yes, you sometimes have to be creative, you shouldn't have very high costs.”