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Determining factors that dominate the adoption of quality standards in the semiconductor industry: a BWM approach

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Determining factors that dominate the adoption of quality standards in the semiconductor industry: a BWM approach

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Preface

I hereby present my master thesis “Determining factors that dominate the adoption of quality standards in the semiconductor industry: a BWM approach”. This thesis has been written in partial fulfilment of requirements of the Management of Technology program. The research was conducted from February 2022 to July 2022.

First, I would like to thank my coordination professor Dr. Geerten van de Kaa for his supervision during my thesis. I found the theoretical discussions and feedback on the reports’ context always very interesting. It helped me a lot to better understand the theories that have been used and the research itself. I also would like to thank my second supervisor Dr. Linda M. Kamp for her feedback during the limited formal meetings. Furthermore, I would like to thank all the experts who took part in the study and the company that gave me an internship position. The experts provided insights and data which would otherwise not be gained. Finally, and maybe most important, I would like to thank my family, girlfriend and friends for supporting me during the period in which the study was conducted.

Maarten Jurg
Delft, July 2022

Executive summary

The topic of standardization is an underexamined research field. Let alone the specific case of quality standard adoption in the semiconductor industry this study focuses on. Quality standards are developed to distinguish low from high-quality products and set up production and development processes. Once standards have been developed, it is not guaranteed that companies will adopt them. Factors often influence adoption. In this thesis, the fictional name GCpuSol is given to an existing company in the semiconductor industry that adopted two quality standards, the ISO 9001 and ISO 13485. This name stands for Gpu Cpu Solutions. Due to privacy concerns the real name of the company has not been given. Both standards are quality management standards, on which they are periodically audited. With these two quality standards, GCpuSol formed an excellent company to study which factors affect the likelihood of adopting this category of standards. Hence, the main research question is *which factors affect the adoption of quality standards in the semiconductor industry, according to experts?*

Factors have been found by conducting a literature review and by interviewing experts. First, three theories are examined that describe factors on the adoption of innovation and standards; the neo-institutional, network economics, and diffusion of innovation theory. Also, the Technology Organization Environment (TOE) framework has been used to find factors. After that, four structured interviews were followed with experts to find additional relevant factors. Consequently, a list of fifteen relevant factors was derived. The factors are: pressures from government organizations, pressure from non-government organizations, pressures from customer(s), pressures from big player(s), pressure from supplier(s), mimetic pressures, normative pressures, management support, centralization, formalization, organization size, relative advantage, compatibility, complexity, and observability. These factors are separated into three categories: pressure from (external) stakeholders, organizational characteristics, and perceived characteristics of quality standards.

Then, the factors had to be ranked by weighting them with a Multi Criteria Decision Making method; the so-called Best Worst Method is used. This research method was conducted with ten experts. Data from eight of them was consistent enough to be used for the remainder of the study. It turned out that the factors: pressure from customer(s), pressure from big player(s), and management support are the three most relevant factors. Based on quotes from the experts and the BWM results, it can be concluded that quality standards are adopted because they are a must-have for doing business. Customers and big players impose pressure on their clients to adopt quality standards. Pressure from customers describes customers that cannot be chosen, and business is done directly with these companies. Pressure from big players describes the companies that can be chosen; their influence can be denied by not doing business with them. However, their pressure will be transmitted via their customers to other companies in the value chain. The factor management support describes that the top management team makes the final decision on whether to adopt. Adoption will only happen when this group of employees agree. Thereby is it also the case that GCpuSol wants to distinguish themselves in this industry and that they are willing to work hard, structured, and orderly to accomplish goals. This led in the first place to the adoption of ISO 13485. They were among the first companies that adopted the ISO 13485.

This study is one of the first to investigate the adoption of quality standards by using a list of determinants and weighing them on their importance with the BWM. Some new contributions have been made to the existing literature on standard adoption and the literature from which the factors are derived. Multiple factors from the neo-institutional theory indicates a strong

relationship with the adoption of quality standards and two factors from the category, organizational characteristics, that have been derived from the TOE framework. It turns out that the factors can be minimally influenced. According to the experts, pressure from other companies can only be influenced by conversing with them. Once a customer imposes the adoption of a quality standard, one must adopt it. Denial might bring the risk of losing that customer.

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List of acronyms

Best Worst Method	(BWM)
Diffusion of Innovation	(DOI)
International Organization for Standardization	(ISO)
Multi Criteria Decision Making method	(MCDM)
Management of Technology	(MOT)
Technology Organization Environment	(TOE)

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1. Introduction

1.1 Background

Multiple scholars have written about standardization. 'A "standard" is to be understood, for the present purposes, as a set of technical specifications adhered to by a producer, either tacitly or as a result of a formal agreement' (David & Greenstein, 1990, p. 4). The key aim of standardization is to reduce the number of solutions when using various options simultaneously is inefficient and ineffective (Wiegmann et al., 2017). Examples of standards include the Metric system and USB-C. The primer is a system of measurements, which is essential to guarantee that, for example, one kilogram is interpreted as the same weight on the other side of the world. The latter will become the mandatory EU standard for charging mobile devices in 2024 (van der Beek, 2021). Standardization plays a significant role in shaping new technologies and determining their success. Worldwide organizations certificate their products according to quality standards, a key organizational practice that helped them set up rationalized production processes. One of the most pervasive and influential quality standards is globally identified with the 9000 family standards, belonging to the International Organization for Standardization (ISO) (Guler et al., 2002). However, little attention is paid to quality standards in scientific journals. The topic of standardization is often seen as boring and is therefore unexamined in studies (Wiegmann et al., 2017). Hence, it is a great topic to research to contribute to the standardization literature.

A company with over 300 adopted standards for all kinds of purposes is called in this thesis: GCpuSol, which stands for Gpu Cpu Solutions. This company is based on an existing company in the semiconductor (semicon) industry, however, the name has been anonymized due to privacy concerns. This company produces machines for the semicon industry, which is a highly complex and turbulent environment, and GCpuSol must continuously be innovative and proactive. There is little time between developments, and the requirements for precision, operational reliability and cleanliness are tremendous. Two quality standards, ISO 9001 and ISO 13485, play a prominent role in their company. Both are quality management standards on which they are periodically audited. ISO 13485 is based on ISO 9001 but is meant explicitly for medical equipment production companies.

The adoption of standards is often influenced by factors (Wiegmann et al., 2017). GCpuSol forms an excellent company to study which factors contribute to the likelihood of adopting quality standards in the semiconductor industry. Factors are in this study found by two methods. Firstly, by conducting a literature review on theories and a framework that report adoption mechanisms. These theories are the neo-institutional, network economics, and diffusion of innovation theory. The framework that has been examined is called the Technology Organization Environment (TOE) framework. Scholars in these fields have performed empirical research on the adoption of standards or technology and described factors that lead to the adoption of quality standards. Secondly, qualitative research is performed to find determines. Experts in this industry that work at GCpuSol have been interviewed to find additional factors that have not been found in the literature. Then, the factors had to be weighted to find the order of relevance that lead to adoption. This is done with the help of the Best Worst Method, which is a Multi Criteria Decision Making method.

The report is split into seven chapters: introduction, theory, methodology, results, discussion, conclusion, and reflection. First, the introduction chapter will describe the research problem, objective and questions. Then, findings from other scientific work are integrated into chapter

two, the theory chapter. After that, the methodology chapter explains how the research is conducted, and the BWM is explained. Next, the results chapter presents the list of relevant determinants and the findings from the BWM. Also is in this chapter discussed how the factors can be influenced. Then, the discussion chapter follows, in which the results are elaborated on, and the theoretical contribution, limitations, recommendations for further research, and the practical implications of this study are given. Next, the key findings are summarized in the conclusion chapter, and the answer to the main research question is given. Finally, the evaluation chapter evaluates the thesis and the master's program of MOT.

1.2 Problem definition

GCpuSol operates in an industry in which standards are used for all kinds of purposes. Standards are, for example, used during the development of products that will determine their success, for setting up a safe working environment, and for setting up processes. GCpuSol is aware of the importance of standards. It is for multiple reasons not unlikely that they will have to adopt additional standards in the future. This is, for example, because standards will keep them competitive in the market, they must meet legislation, and they want to work in a structured and orderly manner. However, adopting standards depends on factors (Hovav et al., 2004; Wiegmann et al., 2017). Each standard is adopted by different Motives and thus varies the factors for adoption per standard. The problem is that once standards have been developed, it is not guaranteed that a company will adopt the standards. It also is unlikely that a strongly predictive theory of standard adoption will emerge (Hovav et al., 2004).

1.3 Research objective

The research objective defines the purpose of the study. The scope was set to research factors that lead to the adoption of quality standards after all the standards that GCpuSol has adopted were found. All the standards this company has adopted have been found by conducting two structured interviews with employees of GCpuSol . Both interviews are elaborated in Appendix A: Structured interviews on page 32. GCpuSol forms as a company with over 300 standards, an excellent company to investigate why standards have been adopted. Two standards that play a dominant role and the organization is audited for are their two quality standards; ISO 9001 and ISO 13485. The objective of the study is to find *factors that affect the likelihood of adopting quality standards in the semiconductor industry according to experts.* Consequently, with the help of the research objective, an answer can be given to the research question that is given in the next paragraph.

Once factors are found that lead to the adoption of standards, a deep understanding of the importance and relevance of these factors must be gathered. With these factors, a list of relevant determines can be derived. Then the factors have to be weighed on their importance to find the order of relevance for adopting the quality standards by using a proven research method. This method is the Best Worst Method that will be explained in chapter 3 (methodology).

The following sub-objectives must be achieved to reach the main goal:

1. Factors must be identified by literature review on scientific theories that describe determinants that lead to the adoption of quality standards.
2. Exploratory interviews have to be conducted with experts in the semiconductor industry to find additional factors.
3. A BWM will follow to find the weight of factors and to determine the order of importance that lead to adopting the quality standards. Multiple exerts will conduct the BWM.
4. The final step is to analyse the data, elaborate on the finding and formulate a conclusion.

1.4 Research questions

Based on the problem definition, and to guide the research objective, the following main research question is proposed *which factors affect the adoption of quality standards in the semiconductor industry, according to experts?*

The following sub-questions will be answered to answer the main research question:

1. Which factors are known to affect the likelihood of adopting quality standards according to the literature and experts?
2. What are the most important factors according to experts?
3. Can the factors be influenced, and if so, how?

Chapter 3 explains how these sub questions are answered.

2. Theory

This chapter presents the results of the literature review. It starts with a general description of quality standards. Then scientific theories and studies are given, describing factors that might affect the adoption of quality standards. Table 1 and Table 2 at the end of this chapter give an overview of all the relevant factors found in the literature.

2.1 Quality standards

Blind (2004) gives an all-inclusive overview of standards in his book 'The Economics of Standards'. His work shows the economic impacts and driving forces of standardization by various alluring empirical analyses revealed in both the service and manufacturing sectors. Quality standards are beneficial in sectors with greater sensitivity to quality variations, low marginal costs of providing quality, low elasticity of demand, and low value placed on low-quality service Blind (2004). The attributes of a product is communicated through quality standards. Such standards shaped the access to global value chains in relation to varying consumption features in industrial economies (Ponte & Gibbon, 2005). Quality standards are not solely focussed on products. They also (sometimes exclusively) focus on process and production methods (Giovannucci & Reardon, 2000).

2.2 Adoption theories

Three theories are examined that describe adoption mechanism of standards or innovation. First, the economic theory on standard adoption examines the community effects and describes that standard-setting takes place via a joint agreement between firms. This is especially important for adopting another group of standards: compatibility standards. Companies will meet positive effects in a technical environment through a joint agreement on compatibility (Katz & Shapiro, 1986). However, since the likelihood of adopting quality standards might depend on what others in the industry do and according to this theory, one must have adopted a standard before others follow, this theory might therefore be relevant for this study. Secondly, the neo-institutional theory describes isomorphic pressures that might lead to adoption (Dimaggio & Powell, 1983). These factors are essential because GCpuSol might have to adopt the same standards as other partners in the value chain under pressure from those other partners. Thirdly, the diffusion of innovation (DOI) theory examine the perceived characteristics of standards from the company's perspective. This theory differs from the other two theories because the DOI theory allows companies to investigate why a standard should be adopted or not (Rogers, 1962). A decision for adoption will be based on the standard's characteristics instead of what other companies impose on the value chain.

2.2.1 Network economics

The *network economics* theory describe unaffectable factors, and this theory emphasizes the importance of market characteristics. Key publications of this theory are that of Katz & Shapiro (1985) and Farrell & Saloner (1985). In the primer paper, with the help of a static model of oligopoly, firms' social and private incentives to produce "compatible" or "standardized" products or switch from incompatible to compatible products are analyzed. Compatible goods are interchangeable goods from different manufacturers. An example of compatible products are computer programmes written for one computer and can operate on different computers. Farrell & Saloner (1985) analyze the industrial problem of products that are incompatible with other products and conclude that incompatible products are at a significant disadvantage. Standard-setting can take place non-cooperatively through the bandwagon effect. This effect

might mainly occur when compatibility is an essential consideration for a firm setting its product specifications (Farrell & Saloner, 1985).

2.2.2 Neo institutional

Meyer & Rowan (1977) and Dimaggio & Powell (1983) are *neo-institutional* scholars. The neo-institutional theory studies the behaviour of firms and how they are affected by other organizations in the same environment in which they operate. Meyer & Rowan wrote in 1977 about organizations that adopt the myths of their institutionalized environment. It makes them similar to other organizations in the same environment and increases a firm's ability to survive in a competitive environment (Meyer & Rowan, 1977). Dimaggio & Powell (1983) asked themselves what makes organizations similar. They call the effect of organizations that become similar: homogenization. Homogenization can best be described with the concept of *isomorphism.* This concept means that a unit in a population is forced to resemble the other units with the same set of environmental conditions. Older, larger firms reach a point where they dominate their environment instead of adjusting to them. There are two types of isomorphism, institutional and competitive. Competitive isomorphism applies to organization fields whereby free and open competition exists. Institutional isomorphism can be used to understand the politics and ceremonies that come into play with many modern organizations. Three mechanisms are defined through which institutional isomorphic change occurs, leading to homogenization. These mechanisms are coercive pressures, mimetic pressures, and normative pressures (Dimaggio & Powell, 1983).

One paper has been found that used the neo-institutional theory to study the cross-national diffusion of the ISO 9000 quality standards. This is the study by Guler et al. (2002). These scholars conclude that coercive pressures are generated by foreign multinationals and powerful organizations such as the state. Normative and coercive effects are generated by cohesive trade bonds between countries, and competitive- and learning-based imitation are the result of role-equivalent trade relationships (Guler et al., 2002).

2.2.3 Diffusion of Innovation

Rogers (1962) developed the *diffusion of innovation* theory, also referred to as the *innovation adoption and diffusion*. Roger's textbook has become the primary reference for diffusion studies (Sahin, 2006). Often, the time between the availability of innovation and when it is widely adopted is covered over a lengthy period. Roger's work taps into the gap between what is known and happening during innovation diffusion. The most striking feature of Rogers's theory is that most system members' innovation decision is based on the decision made by other system members, not on scientific research by experts. Uncertainty about the advantages and disadvantages of innovation is the main obstacle that enables the activity of information-seeking and information processing by individuals. The innovation diffusion process is described as a process that reduces uncertainty. The members of a social system perceive five characteristics of an innovation, which determine the adoption rate. Five attributes of innovation are (1) relative advantage, (2) Compatibility, (3) complexity, (4) trialability, and (5) observability. The adoption rate of innovations is predicted by how individuals precept these characteristics. An innovation that offers these five factors will be adopted faster than other innovations (Rogers, 1962). Although Rogers's theory has been developed on the diffusion of innovation, it also applies to standards adoption (Hovav et al., 2004). A study, with a DOI approach on the adoption of the ISO 9001 standards within higher education institutions in Lithuania, is that of Kasperavičiūtė-Černiauskienė & Serafinas (2016). These scholars concluded that relative advantage and complexity are positively associated with the adoption of the ISO 9001 standard,

while observability and complexity have no effect on the adoption of this standard (Kasperavičiūtė-Černiauskienė & Serafinas, 2016).

2.3 TOE framework

Tornatzky & Fleischer (1990) developed the Technology Organization Environment (TOE) framework. It is a framework that explains, with the help of three different elements, the adoption decisions of innovation from the context of a firm. As can be seen in Figure 1, these three elements are the technological, organizational, and environmental contexts. In various studies on innovation adoption, this framework has been used, but it can also be used to investigate standard adoption (Baker, 2012). The TOE framework overlaps with the adoption theories that are described in section 2.2. The TOE's technology element includes the DOI theory, and the environment element is based on the neo-institutional theory. The organizational element describes, as the name already would suggest, organizational determines, which are management support, centralization, formalization, and organization size. Hashem & Tann (2007) investigated the adoption of ISO 9000 series standards for Egyptian manufacturing companies by using the TOE framework. They found that all three elements are significantly associated with the adoption of ISO 9000 standards (Hashem & Tann, 2007).

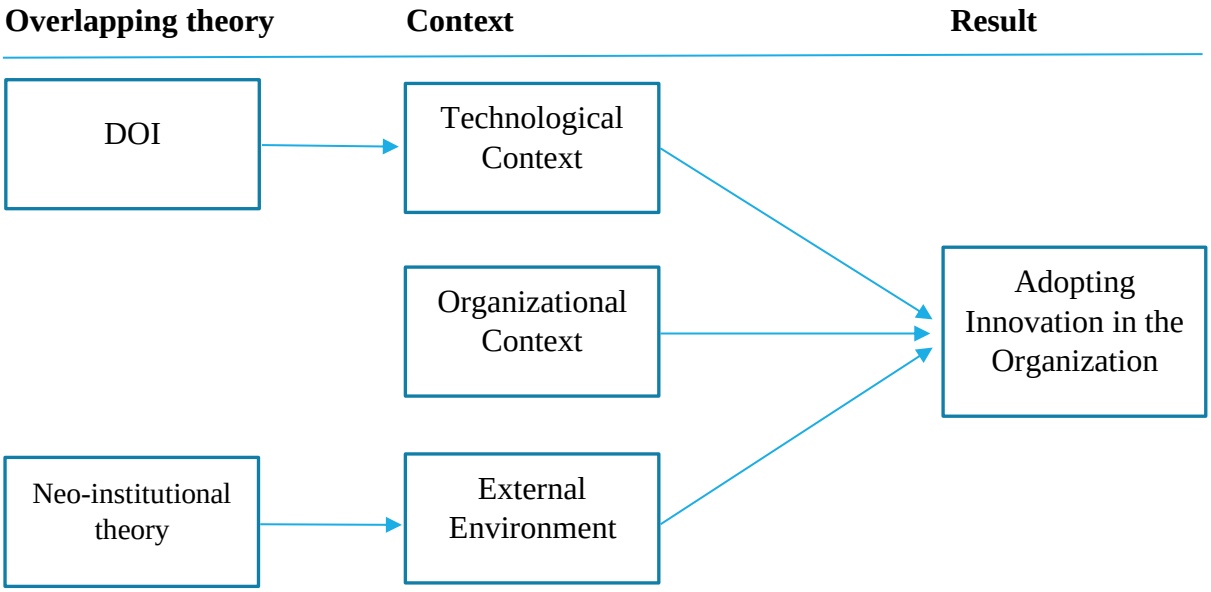

Figure 2, TOE framework

2.4 Overview of the theories with factors and TOE framework

Now that the theories are explained, an overview is given of the factors that belong to those theories in Table 1. The factors per theory are given in the left column, with the explanation of each factor in the right column.

Table 1, neo-institutional, network economics, and diffusion of innovation theory with their factors and explanation

1. Neo-institutional theory	
Coercive pressures	External stakeholder, such as organizations, government authorities, and suppliers and customers exert this pressure. They impose intense pressure like norms and values, regulations, sanctions, and rules (Dimaggio & Powell, 1983; Latif et al., 2020).
Mimetic pressures	This type of pressures is caused by uncertainty as a powerful force that encourage organizations to imitate others. Mimetic pressures arise when

	organizations engage in looking for competition superior performance (Dimaggio & Powell, 1983; Latif et al., 2020).
Normative pressures	This last type of isomorphic arises from standards, values and norms, and expectations within the company culture. Normative pressures push organizations to adopt new behaviours and actions (Dimaggio & Powell, 1983; Latif et al., 2020).
2. Network economics theory	
Bandwagon effect	The barrier to adopting standards is lowered by other companies in the industry that have already adopted the standard. Later movers can, through this effect, be influenced by early movers: if company one switches to a standard, company two might find switching to that standard more attractive than when company one had not switched (Farrell & Saloner, 1985; Katz & Shapiro, 1985).
3. Diffusion of Innovation theory	
Relative advantage	Measures the degree to which an innovation offers advantage and is perceived as being better than the innovation that it will replace or which it is competing against. By adopting ISO standards, companies might meet positives effects, such as satisfying customers, increased sale and profits, reaching new markets, and gaining competitive advantage (Hashem & Tann, 2007; Rogers, 1962).
Compatibility	Refers to the extent to which an innovation can co-exist and is compatible with existing innovations (Rogers, 1962).
Complexity	Refers to the degree to which an innovation can be used and is understandable, but also how challenging it for the company is to adopt the innovation (Rogers, 1962).
Trialability	Describes the degree to which an innovation can be tried out with the least amount of resources and commitment (Rogers, 1962).
Observability	The extent to which an innovation is anticipated as being consistent with the need of potential adopters, the existing values, and past experience, ant the extent to which the benefits or results of the innovation are visible (Rogers, 1962).

Tornatzky & Fleischer's (1990) TOE framework is presented in Table 2 as how Hashem & Tann (2007) used it. The framework exists out of three categories (perceived characteristics of ISO standards, characteristics of the external environment, and organizational characteristics). The category ‘perceived characteristics of ISO standards’ includes four of the five determines by Rogers (1962) (relative advantage, compatibility, complexity, and observability). Quality standards cannot be pre-tested; the determine ‘trialability’ is therefore not included in the framework (Hashem & Tann, 2007). The category ‘organizational characteristics’ describe factors within the organization that lead to standard adoption, which are centralization, management support, organization size, and formalization. The third category ‘external environment’ describe environmental variables which have a vital role in adopting standards. The factors that belong to this category are external support, external pressure, competitive pressure, and environmental uncertainty.

Table 2, TOE Framework by Tornatzky & Fleischer (1990), used in Hashem & Tann (2007)

Perceived characteristics of ISO standard	Describe the perceived characteristics of the standard by the potential adopters (Hashem & Tann, 2007).
Relative advantage	Measures the degree to which a standard offers advantage and is perceived as being better than the standard that it will replace or which it is competing against. By adopting ISO standards, companies might meet positives effects, such as satisfying customers, increased sale and profits, reaching new markets, and gaining competitive advantage (Rogers, 1962; Hashem & Tann, 2007).
Compatibility	Refers to the extent to which a standard can co-exist and is compatible with existing standards (Rogers, 1962; Hashem & Tann, 2007).
Complexity	Refers to the degree to which a standard can be used and is understandable, but also how challenging it for the company is to adopt the standard (Rogers, 1962; Hashem & Tann, 2007).
Observability	The extent to which a standard is anticipated as being consistent with the needs of the organization, the existing values, and past experience, and the extent to which the benefits or results of the standard are visible (Rogers, 1962; Hashem & Tann, 2007).
Characteristics of the external environment	the adoption of ISO standards is influenced through strong (external) stakeholders (Hashem & Tann, 2007).
Competitive pressure	The adoption of standards is influenced through pressure from competitors within that sector (Hashem & Tann, 2007).
Environmental uncertainty	Standard adoption is a positive associated with the level of environmental uncertainty (Hashem & Tann, 2007).
External pressure	External parties may force organizations to adopt the standard (Hashem & Tann, 2007)
External support	Standard adoption is positively associated with the level of external support (Hashem & Tann, 2007)
Organizational characteristics	Standard adoption is encouraged within the organization (Hashem & Tann, 2007).
Management support	The adoption of quality standards is supported by top management within the organization (Hashem & Tann, 2007)
Centralization	The organization structure is highly centralized, which refers to the concentration of decision-making activities and authorities, and will therefore more likely be positively associated with the adoption of quality standards (Hashem & Tann, 2007)
Formalization	The extent to which the organization works according to procedures and formalized rules has an effect on the adoption of quality standards (Hashem & Tann, 2007).
Organization size	The size of the organization has an influence on the adoption of quality standards (Hashem & Tann, 2007). A large organization is, for example, more interested in adoption quality standards than a small organization.

3. Methodology

In order to answer the main research question, primary and secondary data was collected. Interviews are conducted to collect primary data. Secondary data is collected from scientific papers. The theoretical foundation is mainly based on secondary resources that are in line with the topic of this study.

Answering sub question 1: "*Which factors are known to affect the likelihood of adopting quality standards according to the literature and experts"?*

To find out what essential factors are for adopting quality standards in this industry, relevant factors in standard- and innovation adoption literature were firstly subtracted (Rogers, 1962; Meyer & Rowan, 1977; Dimaggio & Powell, 1983; Farrell & Saloner, 1985; Katz & Shapiro (1985); Tornatzky & Fleischer, 1990). Then, experts in the semicon industry were interviewed to find additional factors and to make the list of factors as complete as possible. All the interviewed experts are employees from GCpuSol. Shanteau et al. (2002) give an overview of nine criteria that indicate whether someone is an expert. These criteria have been used to find the experts. Expert one was selected on the criteria *expertise*, meaning that someone is seen as an expert with considerable years of experience. The criteria *social acclamation* describes that experts can also be identified by people working in the field (Shanteau et al., 2002). This criterion was used by expert one to designate the other experts. An overview of the experts that have been interviewed is given in
Table 3. The interviews were unstructured, meaning no predetermined questions list was used. Instead, the experts' answers during the discussion were the input for the following-up questions. During these interviews, the experts were asked what they think have been important reasons for adopting their quality standards without showing them the list of factors from the literature. This list was not shown to them to prevent them from thinking in a biased way, meaning that they would answer in the same way as already explained in the literature. Instead, they had to present their motives for adopting quality standards. Finally, a list of determinants with factors from the literature and unstructured interviews was created. This list is needed to answer the second sub-question.

Table 3, Experts overview

Expert	**Background**	**Years of working experience**
1	Industry	34
2	Industry	30
3	Academic & Industry	25
4	Academic & Industry	27
5	Academic & Industry	24
6	Industry	30
7	Academic &Industry	19
8	Industry	29
9	Industry	28
10	Industry	6

Answering sub question 2: *"what are the most important factors according to experts"?*

The Best Worst Method (BWM) is used for this study. This is a Multi Criterai Decision Making Method (MCDM), which is a suitable method to identify the weight of the factors. Velasquez et al. (2013) compared thirteen of these methods in 2013 and derived to a table with advantages, disadvantages and areas of application of each method (Velasquez et al., 2013). Two years later was a new MCDM introduced; the Best Worst Method by Rezaei (2015). The BWM is a numeric technique whereby participants choose among a discrete set of different decisions. Two pairwise comparison vectors (best-to-others and others-to-worst) are used with this method. These vectors are the input for an optimization model to get the optimal weights of the criteria (Rezaei, 2020). Therefore, it gives more reliable answers than other MCDM. Another advantage is that is it simpler, and need less comparison data (Rezaei, 2015, 2020). The method also knows some limitations, for example, it can't identify a global optimal solution of the system. The final result is only affected by weight given to the criteria, and the calculation becomes very complex when to many criteria points have to be identified (Bai, 2018).

The BWM is conducted with experts one to ten via an interview. During these interviews, the method was visualized, and the candidates were explained how it works. By conducting the BWM in the form of interviews, the decision-makers could be asked to elaborate more on their decisions. By doing so, the candidates made valuable statements about their decisions. These statements are qualitative and essential to consider during the discussion.

The Best Worst Method consist of five steps:

Step 1 - A list of decision criteria must be defined $\{c_1, c_2, \dots, c_n\}$, which are relevant determines that came out of the previous chapter.

Step 2 - The most- and least important criterion for adopting quality standards must be determined through interviewing the experts.

Step 3 - Once the most important criteria is determined is must be compared with the other criteria. A number lying between 1 and 9 must be assigned to the criterion. Where 1 means that the best criteria is as important as the other criterion and 9 means that the best criteria is absolutely more important than the other criterion. This will result in the B-O vector (Best-to-Others).

$B - O = (a_{B1}, a_{B2}, \dots, a_{Bn})$

Step 4 : The other criteria must be compared to the least important criteria. A number lying between 1 and 9 must be assigned to the criterion. Where 1 means that the other criterion is as important as the worst and 9 means that the other criterion is absolutely more important than the worst criterion. This will result in the O-W vector (Others-to-Worst)

$O - W = (a_{1W}, a_{2W}, \dots, a_{nW})^T$

Step 5 - The last step is to calculate the optimal weight by using the two sets of parwise comparison rankings from step 3 and 4 as input for determining the optimal weights of the criteria. The following problem must be solved to accomplish this:

$min\ \xi$

$s.t.$

$$\left|w_B - a_{Bj}W_j\right| \leq \xi, for\ all\ j$$

$$\left|w_j - a_{jw}W_w\right| \leq \xi, for\ all\ j$$

$$\sum_j W_j = 1$$

$$W_j \geq 0, for\ all\ j$$

By solving this problem, the optimal weights can be calculated $(w_1^*, w_2^*, \ldots, w_n^*)$ and consistency ratio ξ^*.

This consistency ratio will be used to verify whether the answers of the expert are reliable. A consistency ratio that is close to zero tells that the data from that experts are consistent and can be used for the remainder of the study.

Answering sub question 3: *"can the factors be influenced, and if so, how"?*

Resulting from the BWM interviews, the order of importance of the factors is identified. thereafter it was relevant to find out whether the most important factors can be influenced. More specifically, when the experts are aware of the most influential factors that lead to adoption, they are also aware of the mechanism that affects the adoption of quality standards. Therefore, follow-up interviews were conducted with experts to discuss their views on the mechanism and possibilities to influence it. Answering this sub-question was solely based on non-structured interviews with experts.

4. Results

This chapter presents the findings from the exploratory interviews, BWM, and follow-up interviews. First, some background information is given about the organization. Then, an elaboration on the findings from the exploratory interviews is given and the final list of determines. After that, the findings from the BWM interviews are given. Finally, the finding from the follow-up interviews is elaborated on.

4.1 Adopted standards by GCpuSol

GCpuSol has adopted over 300 standards, two of which are quality management standards. These are the ISO 9001 and ISO 13485. More than two decades ago, GCpuSol adopted the ISO 9001, it is a model of quality assurance for companies that are involved in development, designing, installation, production, and servicing (Hashem & Tann, 2007). Some years later, GCpuSol adopted the ISO 13485. It is based on the ISO 9001, but then specifically meant for organizations that manufacture, design and develop, and install and service medical devices (DQS-HK, 2016). The organization is periodically audited on these two standards. GCpuSol meets positive effects by those standards, for example, the ISO 13485 allows them to produce machines for the medical industry. In addition, because they hold the ISO 13485 certification, they attract new customers with a demand for making products in an ISO 13485 certified company. According to expert two, there are three primary reasons for adopting standards, which are (1) the environment in which products are made must comply with regulations and requirements set by the market and government; (2) the products themselves must comply with regulations and requirements set by the market and government.; and (3) GCpuSol must comply with the Dutch 'ARBO' legislation. The rest of the 300 plus Standards are mainly seen as guidelines by GCpuSol. Such as the EC60601, which is a series of technical standards that is part of the CE (Conformité Européene) guidelines to guarantee that their products are safe and perform well. Other guidelines that are part of the 300 plus standards are guidelines to which a machine must adhere. An example is ISO 2768: a tolerance standard, which tells them the tolerances to which parts must be designed. Such guidelines are adopted when products are designed. The reason for adopting these standards is that machines must comply with regulations, and they must be designed according to the CE guidelines. Such standards, that are seen as guidelines, are presented by the customers who demand GCpuSol to design a machine. GCpuSol firstly checks whether they have already adopted the standard, otherwise they adopt. The machines are then designed according to these standards. When a machine is produced by GCpuSol , they are prohibited to certify their machine according to the guidelines that are used during the development. Although GCpuSol has a large amount of standards, the BMW will only be focused on the likelihood that quality standards are adopted.

In addition, ASML and other major customers such as Thermo Fischer and ZEISS have imposed and are still imposing standards on GCpuSol. These include but are not limited to standard work methods, procedures, templates, assembly work instructions, and a glue standard (European Bonding standard). These standards are not official standards made by a standardisation bureau but are agreements between the companies to ensure they operate in a structured way. Currently, these major customers want GCpuSol to adopt more standards that they are also using. An example of standards that ASML wants GCpuSol to adopt are GSA standards. these are registration system standards. ASML want GCpuSol to adopt the same standards to guarantee that GCpuSol is just as coordinated as they are.

4.2 Relevant factors

Figure 2 shows a schematic overview of how the final list of categories and factors is constructed. The categories are based on the TOE framework, and the factors are derived from the neo-institutional theory, DOI theory, and TOE framework.

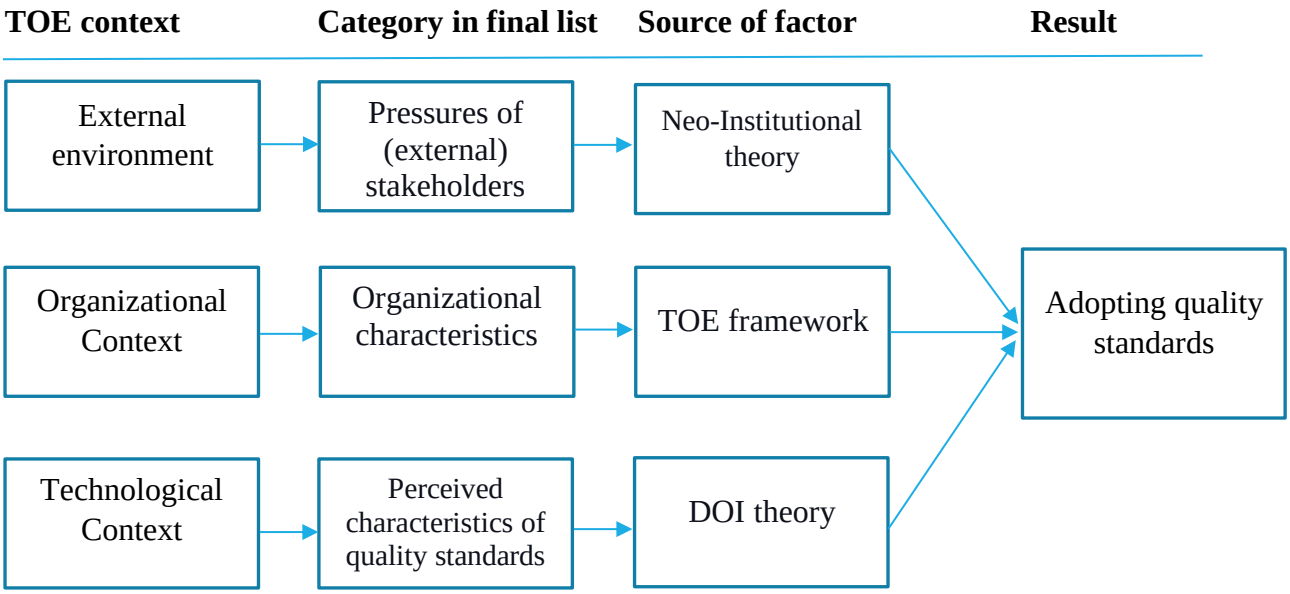

Figure 3, Schematic construction overview of the final list of factors

Table 4 on the next two pages presents the final list of all the relevant categories and factors that the experts ranked. Explanations of the factors are shortened and simplified to make it easier for candidates to understand what is meant by the factors.

Categories

1. Pressures of (external) stakeholders
2. Organizational characteristics
3. Perceived characteristics of quality standards

Category one describes pressure by (external) stakeholders. The factors that belong to this category are from the neo-institutional theory. This category describes pressure that might not only be exerted by external stakeholders such as the government, or customers, but also by stakeholders within the organization. Category two describes organizational characteristics. The factors that belong to it are extracted from the paper by Hashem & Tann (2007). Finally, category three describes the perceived characteristics of quality standards. The factors that belong to this category are from the DOI theory.

The factor *coercive pressures* describe formal and informal pressures that stakeholders exert. The perception of stakeholders is broad, and with the help of the insight that is obtained during the interviews, it is subdivided into five different factors: pressures from government organizations, pressure from non-government organizations, pressures from customer(s), pressures from a big player(s); and pressure from supplier(s). Experts mean multiple aspects of these pressures. The government might exerts formal pressure on companies to adopt quality standards. Expert five said that ISO 13485 is a hard requirement, meaning that the government obligates medical production companies to hold a medical quality management standard. The experts mean with the *pressure from non-governmental organizations* that organizations who are not GCpuSols' customers, not operating in the semicon industry, and are non-governmental

also exert pressure on organizations to adopt standards. For example, when the ISO updates one of its standards, companies that have adopted it must adopt the newer version. ISO 9001-2008 was once replaced by ISO 9001-2015, and GCpuSol had to adopt this more recent version. The factor *customers* describe the direct customers with whom business is done. Almost all experts said during the exploratory interviews that GCpuSols' customers required them to adopt quality standards. The factor pressur from *big player(s)* describes the customers that can be chosen to do business with and do not have to be GCpuSols' direct customer. Factor five *pressure from suppliers* describes the suppliers that deliver components, such as plate material, sensors, PCBs, bearing, etc. It has been added to find out the suppliers' role on which quality standards are imposed by their customers. Factors from the innovation adoption and diffusion factors are neither implicitly nor explicitly mentioned by one of the experts. According to a single expert, ISO 13485 is seen as a better standard than ISO 9001. Expert four said that when GCpuSol adopts a quality standard that goes beyond the quality standards of ASML, GCpuSol will probably adopt it. The expert meant that adopting an even better standard than ASML will make an organization very attractive, and clients are eager to keep doing business with that organization.

Table 4, Fianl list of relevant factors to be ranked with the BWM

Category/ factor		Explanation
1. Pressure of (external) stakeholders		The adoption of quality standards is influenced through pressure from stakeholders.
1.	Pressures from the government	The adoption of quality standards is imposed by the government. Which means that standards must be adopted according to legal terms.
2.	Pressure from non-government organizations	Companies that are not operating in the semicon industry and are not customers (e.g. climate organizations, ISO) impose the adoption of quality standards.
3.	Pressures from customer(s)	Direct business partner(s) that cannot be chosen are imposing the adoption of quality standards.
4.	Pressures from a big player(s)	Major customers (ASML, Thermo Fischer, ZEISS) that can be chosen to do business with are imposing the adoption of quality standards.
5.	Pressure from supplier(s)	Component suppliers are imposing the adoption of quality standards.
6.	Mimetic pressures	Uncertainty leads to copying behaviour, consequently, the same quality standards that other companies in the semicon industry adopted, are adopted to overcome this uncertainty.
7.	Normative pressures	Within the company culture, actors bring the adoption of quality standards as a means of 'I think we should adopt it' (Dimaggio & Powell, 1983).
2. Organizational characteristics		Standard adoption is encouraged within the organization (Hashem & Tann, 2007).
8.	Management support	The adoption of quality standards is supported by top management within the organization (Hashem & Tann, 2007).
9.	Centralization	The organization structure is highly centralized, which refers to the concentration of decision-making activities and authorities, and will therefore more likely be positively associated with the adoption of quality standards (Hashem & Tann, 2007).

10.	Formalization	The extent to which the organization works according to procedures and formalized rules has an effect on the adoption of quality standards (Hashem & Tann, 2007).
11.	Organization size	The size of the organization has an influence on the adoption of quality standards (Hashem & Tann, 2007). A large organization is, for example, more interested in adoption quality standards than a small organization.
3.	**Perceived characteristics of quality standards**	Describe the perceived characteristics of the quality standard by the potential adopters. Positive characteristics of a quality standard leads to adoption.
12.	Relative advantage	By adopting quality standards, companies might meet positives effects, such as satisfying customers, increased sale and profits, reaching new markets, and gaining competitive advantage (Hashem & Tann, 2007; Rogers, 1962).
13.	Compatibility	Refers to the extent to which a quality standard can co-exist and is compatible with existing standards (Rogers, 1962; Hashem & Tann, 2007).
14.	Complexity	Refers to the degree to which a quality standard can be used and is understandable, but also how challenging it is for the company is to adopt the standard (Rogers, 1962; Hashem & Tann, 2007).
15.	Observability	The extent to which a quality standard is anticipated as being consistent with the needs of the organization, the existing values, past experience, and the extent to which the benefits or results of the standard are visible (Rogers, 1962; Hashem & Tann, 2007).

4.3 BWM Results

The results of the BWM analysis are given in this section. Table 5 presents the consistency ratio of all experts, and Table 6 on the next page presents the outcome of the BWM. The consistency ratio of expert four and nine are considered too high. Therefore, the data from these candidates is not be included in the results table. The rest of the experts' consistency scores are considered consistent.

Table 5, Consistency ratio of the experts

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10
Categories	0,08889	0,125	0,06818	0,04167	0,15	0,1125	0,0417	0,0865	0,1818	0,11364
Pressure from (external) stakeholders	0,09714	0,05276	0,15618	0,04576	0,1125	0,08721	0,068	0,1097	0,0496	0,14001
Organizational characteristics	0,10976	0,10638	0,12838	0,27273	0,06593	0,08537	0,0517	0,0972	0,1627	0,09538
Perceived characteristics of quality standard	0,09459	0,06504	0,08462	0,125	0,05405	0,10588	0,0921	0,1176	0,1813	0,14286

Table 6, BWM results

Categories & Factors		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10	**Local average weight**	**Global average weight**	**Ranking Factors**
Pressure from (external) stakeholders		**0,64444**	**0,70833**	**0,81818**		**0,65**	**0,675**	**0,16667**	**0,14423**		**0,56818**	**0,54688**		**1**
1.	Pressures from government organizations	0,30908	0,27889	0,05857		0,03333	0,06977	0,13037	0,03133		0,07513	0,12331	0,33509	5
2.	Pressure from non-government organizations	0,13541	0,08291	0,02386		0,05833	0,05814	0,02834	0,05875		0,03073	0,05956	0,30322	9
3.	Pressures from customer(s)	0,20311	0,23367	0,37093		0,4125	0,26163	0,19555	0,36031		0,38589	0,30295	0,42491	1
4.	Pressures from big player(s)	0,20311	0,16583	0,37093		0,175	0,34884	0,19555	0,36031		0,1753	0,24936	0,39812	2
5.	Pressure from supplier(s)	0,05803	0,11055	0,05857		0,05833	0,0436	0,07822	0,07833		0,06574	0,06892	0,3079	7
6.	Mimetic pressures	0,02355	0,04523	0,05857		0,175	0,0436	0,04889	0,05222		0,06574	0,0641	0,30549	8
7.	Normative pressures	0,0677	0,08291	0,05857		0,0875	0,17442	0,32308	0,05875		0,20148	0,1318	0,33934	4
Organizational characteristics		**0,24444**	**0,08333**	**0,09848**		**0,26667**	**0,2625**	**0,29167**	**0,77885**		**0,34091**	**0,29586**		**2**
8.	Management support	0,54878	0,57181	0,04054		**0,3956**	0,39024	0,46552	0,13607		0,56358	0,38902	0,34244	3
9.	Centralization	0,04878	0,13564	0,31081		0,05495	0,15854	0,10345	0,054		0,16474	0,12886	0,21236	11
10.	Formalization	0,32927	0,22606	0,49324		0,3956	0,39024	0,25862	0,58315		0,21965	0,36198	0,32892	6
11.	Organization size	0,07317	0,06649	0,15541		0,15385	0,06098	0,17241	0,22678		0,05202	0,12014	0,208	12
Perceived characteristics of quality standards		**0,11111**	**0,20833**	**0,08333**		0,08333	**0,0625**	**0,54167**	**0,07692**		**0,09091**	**0,15726**		**3**
12.	Relative advantage	0,05405	0,47154	0,56923		0,39189	0,6	0,48684	0,23529		0,57143	0,42254	0,2899	10
13.	Compatibility	0,28378	0,26829	0,24615		0,06757	0,08235	0,14474	0,58824		0,04762	0,21609	0,18668	13
14.	Complexity	0,47297	0,0813	0,05385		0,39189	0,14118	0,07895	0,11765		0,2381	0,19698	0,17712	14
15.	Observability	0,18919	0,17886	0,13077		**0,14865**	0,17647	0,28947	0,05882		0,14286	0,16439	0,16083	15

In the right three columns are the local average, global average weight and ranking of the factors presented. The local average weight is the average of all expert scores in one row per category or factor. The global average weight per factor is obtained by dividing the local average weight per factor by the local average weight of the category to which the factor belongs. After that, the factors were ranked in importance. The higher the global average weight, the more important the factor. The factor pressure from customers is the most important factor with a global average weight of 0,425, followed by pressure from a big player(s) (0,398) and Management support (0,342)

4.4 Influencing the factors

In order to answer the third sub-question, follow-up interviews have been conducted with experts two, six, and ten. These interviews are elaborated in Appendix D on page 55. All three experts were asked whether the factors can be influenced, and if so, how? According to all three experts, customer pressure can be somewhat influenced. GCpuSol cannot avoid the pressure, but they can discuss the form of the standard, not the content. Expert two said that the factors in the various categories are related with each other and not isolated. This expert stated, for example: "when our customers impose standards, our management team will also find it important. If we do not listen to our customers, we will have a negative relative advantage compared to our competitors. So there is a correlation between the factors. The factors are not isolated".

Expert six was asked what will happen when GCpuSol does not adopt a quality standard that one of their customers imposes on them. This expert said: "you run the risk of losing the customer. That risk is significant". After that, this expert was asked how GCpuSols' monopoly position is related to influencing the pressure or the demand of their customers. This monopoly position means that GCpuSol is currently producing some machines that are not elsewhere produced, and their customers depend on the machines of GCpuSol . Expert six answered: "yes, at the moment we are the only manufacturers of some machines. But nothing is impossible. Production can always be moved". Next, expert ten answered the question of whether GCpuSol can influence the pressure from customers with the following: "yes, of course, I think that we, as GCpuSol , are very critical of what our customers demand from us. We will always check first if we need the standard and what it will bring us". After that, this expert was asked whether the customers will no longer do business with GCpuSol when they do not adopt the quality standards, also by considering that customers are dependent on GCpuSols' machines. Expert ten stated: "it depends. It almost looks like a sales pitch. It can be a bluff so that they can buy somewhere else machines. But, on the other hand, we do not want to lose production, so we will always keep in conversation with them and maybe look less critical at their pressure".

Expert two was asked whether the pressure from big players can be influenced and answered: "you can decide not to do what they demand, but you will not have them as your customer. We are not on the level that decides which standards to adopt. The companies on that level are sort of protected in the market". And: "looking internally, we can try to influence our customers. Nevertheless, when decisions are made on a corporate level at ASLM or ZEISS, it will be unable to have an influence". This expert was also asked whether there is a factor that can be influenced. The answer was: "in the end, people are the ones who do things. You can write many things down, but people must be convinced. If we are talking about changing things, you write down a process. However, the human being must do it. So influencing change must be human-related". Then, this expert was asked whether influencing the factors is somewhat possible. Expert two answered: "yes, I think so, not by imposing more pressure on the customers, but by having a conversation with them. The chance of change is in the relationship and the soft skills". This answer is in line with what experts six and ten stated. Influencing the pressure of customers is possible by having a conversation with them. Fighting the pressure will probably lead to losing the customer. Furthermore, people within the organization must be willing to support the demand of customers. Only the employees themselves can bring a change in the portfolio of standards or express how they prefer to see the adoption happen themselves.

5. Discussion

This chapter evaluates the results from the BWM. An elaboration of the results is given, supported by statements from the interviewees and other scientific work. Appendix C on page 42 presents summaries of the of the BWM interviews. Furthermore, in this chapter are the theoretical contribution, limitations, and ideas for further research explained.

5.1 Outcome of the BWM

An elaboration on the outcome of the BWM is given in the following paragraphs, supported by quotes from the experts.

Pressure from customer(s)

Almost all experts said during the BWM interviews that quality standards are adopted because they must do it from their customers. Experts stated the following. Expert two: "the customers ask us to adopt a standard". Expert three: "you will not get an assignment from a big company such as ASML when you do not have the ISO 9001. ISO 13485 is also externally determined. The bottom line is that you must have the ISO 9001 and ISO 13485 to do business in this industry. The 9001 is a sort of a must-have standard in our industry, that is why we have adopted it.". Later, this expert added: "in my experience, we adopt these standards because customers want us to adopt them". Expert four: "I think the demand originates from the customer". Expert five was asked why he thinks GCpuSol has adopted the ISO 9001, this expert answered: "many customers demand it from us". Expert six: " pressure from customers is the most important. They impose standards on us". Expert ten: "quality standards have once been developed, and someone said that companies in this industry must adopt it. Pressure from the customers is the most important".

The factor pressure from customers originates from the factor coercive pressure from the neo-institutional theory. Meyer & Rowan (1977) stated that organizations adopt the same myths of their institutionalized environment. Dimaggio & Powell (1983) explained that companies are forced by others in the same environment to resemble them with the same set of environmental conditions. It can be concluded that this effect is also present in the semicon industry. Guler et al. (2002) also found that coercive- and normative pressures play an important role in the cross-national diffusion of ISO 9000 standards. Similarly to Hashem & Tann (2007), who conclude that external pressure has an positively influence on the adoption of quality standards. Georgiev & Georgiev (2015) give in their work an overview of seventeen papers on the topic of factors for obtaining an ISO 9000 certification in various countries. In this overview, the factor *customer pressure* seems to be overwhelmingly important for obtaining an ISO certification (Georgiev & Georgiev, 2015). Based on the literature, experts' quotes, and outcome of the BWM, it can be concluded that customers impose pressure on their clients and force them to adopt quality standards. Especially ISO 9001 is seen as a must-have standard in the industry. This is in line with the existing literature on quality standards adoption.

Pressure from big player(s)

The second most crucial factor is *pressure from big player(s).* Some experts' statements are the following. Expert one: "first, we must have customers before we can feel pressure from a big player. As a company, you are working towards attracting customers". Expert two: "of course, what the big player demands from customer X will also be transferred via customer X to us, but we do not do what the big players demand in the first instance. Only when the big player becomes a customer of us". Expert eight: "customers and the big players are the most important

factors in the first category, because when we deliver our machines to the company VDL, then they deliver it to ASML, and ASML is the end customer". The factor big player(s) describes customers that can be chosen. These quotes confirm that such companies are also important when it comes to adopting quality standards. Customers that can be chosen might impose pressure, but this pressure is not directly exerted on GCpuSol. Instead, this pressure is transmitted from a customer to a customer, as expert two explained. Thus even though customers can be chosen, and their pressure can be ignored by not doing business with them, it will still be transmitted via other companies and influence the rest of the organizations in the value chain.

Management support and normative pressure

The factor *management support,* belonging to the second category, has been ranked as the third most important. *Normative pressure,* belonging to second category scores with a global average weight of 0,339, just below management support (0,342), as fourth most important. These two factors overlap in their definition, and their score proves that the experts see this as a somewhat equally important factor. Both factors describe a mechanism in which the organization itself strives to adopt quality standards. Normative pressure describes pressure from actors within the organization, and management support describes that actors within the organization support the adoption. According to experts one, two, four, five, seven and ten, management support is the most important factor in the second category. Some experts' quotes to what they think is the most important factor in the second category are the following. Expert two: "management support is the most important. Adoption will only happen when they want to adopt it". With 'they' this expert meant the top management team. Expert four: “management support will always be the most important factor. You cannot do it when the management team does not support the adoption”. And “the success of adoption depends on management support”. Expert seven: “management support makes the decision, and we noticed that our management team was pushing to improve the quality to prevent disapproval of products. Expert ten: "Management support. The company itself has the final word to impose a standard or not".

The factor management support is derived from the TOE framework. Hashem & Tann (2007), who contra dictionary with the results of this study conclude that management support is insignificant related with the adoption of ISO 9000 standards. Abrahams' et al. (2000) results are in line with that of this study regarding management support. Certification of ISO 9000 standards itself offers little guarantee for successful outcomes. The management support plays an important role with strategizing the implementation and to obtain proper performance outcomes (Abraham et al., 2000). Gupta (2000) found that adoption of quality standards seems to be primarily internally driven. This result is in line with the quote from expert ten that was made during a follow-up interview: “I am very much of the bottom-up, so employees within the company indicate something. That leads to organizational characteristics. Internal pressure might lead to adopting quality standards to serve the customer better. I believe in this mechanism”. Based on the quotes and the outcome of the BWM, it can be concluded that management support and normative pressure describe important mechanisms for adoption quality standards. Adoption will only happen when is it is supported by the top management team. This team makes the final decision. It is also the case that within GCpuSol , efforts are made to perform as well as possible or improve performance. An actor who strives for improvement is taken seriously, which might lead to adopting a quality standard.

Pressure from government organizations

According to some experts, the factor p*ressure from government organizations* is also very important and, to others, less important. It has been ranked in the fifth position. Experts one and

two answered to the question *what is the most important factor in the first category* the following. Expert one: "government pressures, because we must meet legislation. The customers are almost as important". Expert two: "the government is the most important because we must act as a legal company" and "the government would not impose the ISO 9001 on companies. However, the medical device regulation is a law. Companies like us, who produce medical devices, must have adopted a medical quality standard. So, therefore, we adopted the ISO 13485". Other experts said something in contrast to what experts one and two said. For example, experts three and six were asked whether pressure from government organizations is important. Expert three answered: "no because we are a commercial company. The same account for non-governmental organizations. The company that pays us to do business is the most important". Expert six answered: "no, they say that you must have a standard, but they do not indicate which standard". Expert five stated: "the government is not demanding from us to adopt quality standards". The quote from expert three, again, indicates that pressure from customers is important.

Based on the quotes, there seems to be some discrepancy between the experts about the role of the government. The government did not directly impose quality standards on GCpuSol and did not mandate the adoption of the ISO 9001. However, for some markets, such as the medical industry, the government states that medical production firms must adopt a quality standard. The government does not prescribe a specific quality standard, but a quality standard must be adopted. This applies to GCpuSol , and it was one reason they adopted the ISO 13485. Hovav et al. (2004) investigated the adoption of another category of standards, compatibility standards. They found that the government plays an essential role in sponsoring the adoption of compatibility standards by determining the environmental context for a new standard (Hovav et al., 2004). The sponsorship role of the government has not been included as a factor in the BWM in this study. Revisiting the quotes from the experts, a factor in which a sponsorship role of the government was included in the BWM, just like Hovav et al. (2004) used it to analyze the adoption of compatibility standards, could also have been relevant. The government does not exert pressure on the adoption of a specific standard. However, the government determines sectors where a category of standards is a must-have, as is the case for quality standards in the medical equipment production industry.

Formalization

Formalization, belonging to the second category, has been ranked as the sixth most important factor. Some statements of the experts about this factor are the following. Expert one: "formalization is also important. Somewhat equal to management support". Expert five: "I think management support is as important as formalization". Expert seven: "when we start to grow, formalization will become increasingly important, but the increased complexity of the company will then oppose the implementation. It will cost more effort to adopt standards when we start to grow. Expert ten: "I see formalization as finishing what you have started. I do not see it as a reason to adopt standards". Hashem & Tann (2007) conclude that formalization has a positive relationship with the adoption of ISO 9000 standards, which also applies to this research. It does not describe a mechanism that directly leads to the adoption of quality standards. Instead, it is a means for adopting such standards. When companies are already working in a structured and orderly manner, they might as well adopt standards indicating that they are working according to the norms.

Mimetic pressure and non-governmental organization

The least two essential factors in the first category are *mimetic pressure* and *pressure from non-governmental organizations*. Mimetic pressure can be of influence when other firms have

adopted standards. GCpuSol does not have the urge to copy others. Instead, they strive to improve themselves continuously. For example, experts one and two stated that mimetic pressure is the least important factor. Expert one: "mimetic pressure is the least important". Expert two: "I think that our value chain is more important than a colleague company". However, this expert also stated the following about mimetic pressure "when we are in trouble; we will look at other companies and what they are doing. Our performance is also compared with the performance of other companies. When we would perform poorly, we would copy companies doing better than us". Expert four said something comparable about this factor: "mimetic pressure is somewhat important. Of course, most companies trust in their own capabilities. However, you do not want to differ that much from other companies". Also, for expert six, the least important factor is mimetic pressure. This expert stated: "mimetic pressure is the least important because we do look what others do. However, we do not feel insecure compared to them". Expert eight said something comparable: "mimetic is not important. We are not copying other companies out of insecurity. So I think mimetic pressure is the least important factor". And expert ten stated: "mimetic pressure is not important for us. We really want to do things independently, without copying others".

Based on these quotes, it can be concluded that mimetic pressure is not a reason for GCpuSol to adopt quality standards. This company want to do things in their way and constantly improve themselves without copying others. GCpuSol were, for example, among the first to adopt the ISO 13485 in this industry. On the other hand, Mimetic pressure might play a more critical role with newcomers in this industry, who take a look at other companies and the requirements to join this industry. Non-government organizations have a neglectable interest in companies adopting quality standards because no business is done with these organizations that are not operating in the semicon industry. Such organizations only sometimes indicate what companies ought to do. Pressure is then exerted on the whole industry, which indirectly might lead to pressure and the adoption of quality standards. Expert ten said the following about non-government organizations - "non-government organizations once said to us to stop consuming so much plastic. so they meddle with our industry". Expert three was asked whether governmental organizations influence adopting quality standards. This expert answered - "no because we are a commercial company. The same account for non-governmental organizations. The company that pays us to do business is the most important".

Relative advantage

Relative advantage scored as the tenth most important. However, what is striking is that the local average weight of this factor is the highest of all fifteen factors. The global average weight of this factor is brought down by the low local average weight of the category to which this factor belongs. This explains the tenth position in the ranking. According to all experts but experts one and eight, this factor is the most important in the third category. Expert two explained: “because only when we think a quality standard will bring advantages, we will adopt it. Therefore, relative advantage is an important reason for adopting quality standards in addition to the customer’s requirement”. Two studies on quality standard adoption that used the DOI factors conclude that relative advantage has a positive effect on quality standard adoption (Hashem & Tann, 2007; Kasperavičiūtė-Černiauskienė & Serafinas, 2016). The tenth position does not support the prior findings of studies that report on relative advantage as having a significant influence on innovation adoption (Rogers, 1962; Louis G. Tornatzky & Klein, 1982). In a follow-up interview, expert two stated, “there is a confirmation between the factors. When our customers impose standards, our management team will then also find it important. If we do not listen to our customers, we will have a negative relative advantage compared to our competitors. So there is a correlation between the factors. The factors are not isolated”.

Later, this expert added: “relative advantage is related to pressure from customers. Because when they see the advantage of adopting a standard, and we do not, we will still adopt it”. It can be concluded that relative advantage is within its category a very important factor. Compared to the rest of the factors it is not as important. The factor does not describe a direct mechanism for adopting quality standards. This is because the primar reason for adopting quality standards originates from the demand of the customer.

Centralization and organization size

Something else that stands out is that two factors from the second category are relatively ranked far apart from the other two. The second category's *centralization* and *organization size* are ranked as eleventh and twelfth most important. Experts meant that centralization is not a condition for adopting quality standards, and the size of an organization also has a neglectable influence. Expert one stated: "management support is the most important. The least important is centralization. These two factors can only work against each other. The difference between those is max, I have never seen those two factors working well together in a company". On the factor organization size, the following was said by the experts. Expert one: "organization size is not important because it does not matter whether the company is small or large". Experts two and six stated the same. Their answer to the question *what is the least important factor in the second category* was the following. Expert two: "when a customer imposes a standard on you, it does not matter whether you are small or large". You must adopt it”. Expert six: "organization size, because it does not matter whether the organization is small or large". These statements again prove that pressure from customers is one of the reasons that quality standards are adopted because these customers do not distinguish between small or large companies. Centralization describes how activities are controlled in an organization. The likelihood of adoption does not depend on centralization because the same argument as the organization applies to this factor. Centralization might make it easier to adopt standards, but the need for adoption does not depend on the centralization structure of an organization.

5.2 Research on factors

It turns out that factors from different theories can be used to expose the various motives of a company for adopting quality standards. The factors address motives that led to a particular organizational decision, in this case, quality standard adoption. This study does, however, not provide the go-to list of determines that can universally be used to explain standard adoption. This is because the factors are uniquely selected for this study. Ranking of the factors by using the BWM makes this intangible event of adoption to some degree understandable. Only using factors from one theory would not have been sufficient to get insight into adopting quality standards. Instead, a combination of factors from multiple empirical studies was needed to address these motives. It appears that the isomorphic pressures originating from the neo-institutional theory are the most positively associated with adopting quality standards. Coercive pressure can be split up into different factors, and it turns out that not all five of them are as important. Pressure from non-governmental organizations and suppliers is less important than the pressures by the major multinationals in this industry and pressure from government organizations. Also, normative pressure is more relevant than mimetic pressure. Management support and formalization, originating from the organizational characteristics, seem more important than the other two factors in this category. Furthermore, the factors from the DOI theory seem to be the least important out of the fifteen factors.

The ranking of the factors and the experts' quotes reveal a mutual relationship between the factors from the different theories. As said by one of the experts during the follow-up interviews, ‘the factors are not isolated‘. The expert meant by this, and also can be seen in

BWM results, that not all factors from one category are the most important, followed by the factors from another category. Instead, the combination of different motives led to adoption. For example, pressure from external stakeholders will affect the management team.

This study analyses factors, and it has become clear which factors are the most important. On the other hand, it remains unclear how the factors are exactly interpreted by various actors and what makes them decide to adopt or not. It is unclear how the different actors think, for example, about the pressure of other companies. It is only clear that once pressure is exerted, that adoption will follow, but it is unclear what the negative consequence will be if the adoption does not follow and how actors think about this consequence. The only known effect is that adoption leads to acceptance in this industry since it is required to do business. Therefore, experts think that a company cannot do business or losing the customer will be a negative consequence when not adopting quality standards. However, this line of reasoning does not include the monopoly position of a company that makes machines that are not made anywhere else and on which other companies are dependent. Still, it seems logically explainable that the experts think this way because GCpuSol has always been working according to ISO 9001. The organization has not been in a position where they were excluded from delivering machines to their customers due to not having adopted a quality standard.

5.3 Theoretical contribution

This study contributes to the standardization literature. Standards are becoming increasingly important in a globalized world. However, despite the growing importance of standardization, standards are little scientifically analyzed or discourse addressed (Biddle, 2017). This study specifically focused on quality standard adoption, of which very little can be found in scientific literature. Moreover, studies that are imposed on standard adoption are mainly about compatibility standards. It is the first study on quality standard adoption in the semiconductor industry from the perspective of a company that adopted such standards. Thereby, it is the first study that combines factors from different theories with which a list of determinants is constructed that have been ranked by applying the BWM. According to Schilling's (1998) study, path dependency often controls technology markets which accrue in an orderly way. This scholar identified a set of factors that have a predictable influence on technology adoption. This is in contrast with what evolutionary economics states. According to evolutionary economics, an organization cannot affect its environment. The choice of a firm's strategy and innovation process has a mutual relationship with its environment, which is almost uncontrollable (Utterback & Abernathy, 1975). This study indicates evidence that particular factors contribute to standards adoption rather than being unpredictable. Secondly, a contribution to the TOE framework by Tornatzky & Fleischer, (1990) is made. Using these factors from the TOE framework it can be concluded that this framework can be used to study the adoption of standards. Instead of only being used for the adoption of innovation which it was originally developed for.

5.4 Limitations

A limitation can be denoted in this thesis. Three exploratory interviews were conducted with three experts. Scheduling meetings with the experts was sometimes possible a few weeks after the request was submitted or only directly after the request was submitted. Consequently, some interviews were conducted before all the factors in the literature were found, and others were held after the literature review was completed. Ideally, all the exploratory interviews had been conducted after the literature review was completed; so that the most knowledge from the literature was obtained and the most insightful question could have been asked during the interviews.

5.5 Recommendations for future research

This is the first study that identified factors leading to adopting quality standards in the semicon industry. Further research could be designated to conducting the same research method at another company in the semicon industry and analysing how the findings differ between the companies. In addition, quality standards are thus adopted because it is a requirement to do business. Other companies mainly exert the pressure. This raises an opportunity to study why these companies impose this pressure on the value chain. Said differently, why the pressure comes from these sources can be studied. It is yet unknown what their MoTive is for working according to quality standards and why they demand it from their clients.

5.6 Practical contribution

Besides the theoretical contribution, there are also practical contributions to this research. First, an in-depth analysis is given of the key determines for adopting quality standards, such as pressure from customer(s), pressures from big player(s) and management support. All the factors explain mechanisms associated with the adoption of quality standards. The identification of these factors provides the opportunity for companies to decide whether to enter this industry or not. Company managers can use the outcome of this study to make strategies. New entrants might, for example, use the knowledge in advance to strategize or adjust their business processes before entering the industry. Secondly, the factors are somewhat influenceable. Once the major companies in this industry exert the pressure to adopt quality standards, adoption must follow. Denial will lead to being out of business. However, companies can talk about the form of the standard, not about the content. Therefore, experts think internal motivation within the company is essential for successfully adopting quality standards.

6. Conclusion

The main goal of this study was to assess the weight of factors of influence with the likelihood of adopting quality standards in the semicon industry. This goal was completed by answering the following main research question *which factors affect the adoption of quality standards in the semiconductor industry, according to experts?* Three sub question were proposed to answer this main question. The first sub-question was *which factors are known to affect the likelihood of adopting quality standards according to the literature and experts?* Literature review and interviews with experts were performed to create a list of determines to answer this sub-question. A first list of factors was distilled from three theories and the TOE framework that report on standard and innovation adoption. The theories are the neo-institutional, network economics, and the innovation adoption and diffusion theory. Then, interviews took place with experts from GCpuSol to find additional factors. A final list of fifteen factors was created based on the interviews and on the scientific literature. These factors are: pressures from government organizations, pressure from non-government organizations, pressures from customer(s), pressures from big player(s), pressure from supplier(s), mimetic pressures, normative pressures, management support, centralization, formalization, organization size, relative advantage, compatibility, complexity, and observability. These factors were divided into three categories: pressure from (external) stakeholders, organizational characteristics, and perceived characteristics of quality standards.

To answer the second sub-question *what are the most important factors according to experts?*, an MCDM was conducted with ten experts. The answers of eight out of the ten experts were considered consistent. In Table 7, an overview is given of the weights of the factors that are obtained with the BWM. As can be seen in this table, the factors pressure from customers(s), pressure from big player(s), and management support were ranked as most important, belonging to the categories pressure from (external) stakeholders and organizational characteristics.

Table 7, The obtained local average weight, global average weight and ranking of the factors and categories

Categories & Factors		Local average weight	Global average weight	*Ranking Factors*
Pressure from (external) stakeholders		**0,547**		***1***
1.	Pressures from government organizations	0,123	0,335	*5*
2.	Pressure from non-government organizations	0,060	0,303	*9*
3.	Pressures from customer(s)	0,303	0,425	*1*
4.	Pressures from big player(s)	0,249	0,398	2
5.	Pressure from supplier(s)	0,069	0,308	*7*
6.	Mimetic pressures	0,064	0,305	*8*
7.	Normative pressures	0,132	0,339	*4*
Organizational characteristics		**0,296**		***2***
8.	Management support	0,389	0,342	3
9.	Centralization	0,129	0,212	*11*
10.	Formalization	0,362	0,329	*6*
11.	Organization size	0,120	0,208	*12*
Perceived characteristics of quality standards		**0,157**		***3***
12.	Relative advantage	0,423	0,290	*10*
13.	Compatibility	0,216	0,187	*13*
14.	Complexity	0,197	0,177	*14*
15.	Observability	0,164	0,161	*15*

Adoption of quality standards arises from the pressure placed on suppliers by customers. Working according to the quality standards is required to do business in the semicon industry. Adoption also happens with the support of the top management team. This group of actors within the organization are ultimately the decision-makers who decide whether to adopt or not.

Follow-up interviews were conducted with three experts to answer the third sub-question: *can the factors be influenced, and if so, how?* During these interviews, the experts all said that influencing the most important factors is to some degree possible. However, the pressure from customers cannot be denied. Once a customer demands their supplier to adopt a quality standard, adoption must happen. On the other hand, how this adoption will be executed can be discussed. When adoption does not follow, one can risk losing their customer. Pressure from a big player(s) can directly be ignored by not doing business with such companies. However, the pressure from these companies is transmitted via other companies in the value chain. Consequently, the pressure from a big player(s) will indirectly end up with other companies. The factors management support can be influenced. Eventually are, the employees the ones who must act. Through conversation, one can express their opinion about adopting a standard.

7. Reflection

In this chapter, a reflection is given on how I experienced conducting this study, and the two-year master's program in Management of Technology.

7.1 Reflection on the research

A global idea for this study was established in consultation with my coordinating professor Dr. Geerten van de Kaa. When I started, I had almost no knowledge of standards. Therefore, I interpreted it as a challenging topic to write a thesis about. During the first month, I read much literature on theories that describe adoption mechanisms and less on standards. This made it difficult for me to find out what I wanted to study and scope the topic. After about seven weeks of progress, I knew exactly what I wanted to do. I could have improved this by reading more studies on standardization to find a research opportunity. I worked according a schedule, and every three weeks, I had to finish a chapter so it could be discussed with van de Kaa and three other students that were also writing a thesis. I found this extremely helpful since we got much feedback during those meetings. It is one of the reasons that this study could be finished in five months. However, if I had a few more months, I would have invested more time in conducing the BWM with experts from other companies. This would have led to findings from more companies, after which the results of the different companies could have been compared with each other. This would add an extra dimension to the research. Collecting data was the most challenging part of this study. Contacting experts was not tricky, but getting a reply was. They were often busy or did not respond at al. This could have been improved by arranging meetings even earlier than I already did. For example, instead of contacting the experts two/ three weeks before a meeting, I could have contacted them four or five weeks ahead. Overall I am delighted with the results and everything I have learned from writing this thesis.

7.2 Reflection on MOT

An MOT thesis should have aspects like technology, innovation or strategy and highlight a scientific-analytical study. During the master's program, students are thought to become entrepreneurs or technology managers by learning to evaluate technology from a sustainable or responsible point of view and by considering the continually changing social, technological and economic environment. The aim is to teach engineers to become thoughtful and responsible decision-makers. This study fits within the MOT program due to the analysis that has been performed within a company. Instead of technological breakdown, it reveals by which mechanisms standards are adopted in a specific industry, which could help the policymaker to direct companies to strategize their business to enter the semicon industry. This research has exposed how a (new) company can set foot in an industry. Besides relying on engineers' technological innovation and design capabilities, students who finished the MoT program are of great value to companies differently. As thought during the course' Turning Technology into Business', a highly innovative idea that adds value to society would probably be the entrance into an industry. However, it turns out that a condition for entrance is the adoption of quality standards, which is a non-technical condition but an organizational condition. Thereby, multiple disciplines are spanned in this study, and several concepts from the MOT courses are applied like Preparation for Master Thesis (MOT2004), Technology Battles (TPM959A), Technology, Strategy, and Entrepreneurship (MOT1435), and Research Methods (MOT2312). In my opinion, the program is very well set up with varying and challenging courses. I liked that we could choose a specialization in the second year. Something that could be improved is adding the MCDM to the course Research Methods. The MCDM is only taught during the course Technology Battles.

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Appendix

Appendix A: Structured interviews

Structured interview expert 1

What standards are currently used?
We use different standards such as:

- ISO 13485 (quality management system standard)
- We work according to methods that are made by ASML, such as:
    - European bonding standard (glue standards)
    - bolt/ screw standards
    - Production standard
    - Safety standards
- Accounting standard
- Stock management standard

These are the standards that currently come to my mind.

Which positive effects do you meet by those standards?
The benefits of standards work both ways. On the one hand, the ISO 13485 standard is a certificate that allows us to produce medical certified products. On the other hand, because we are in the possession and allowed to produce medical certified products, we attract new clients.

Another advantage of standards is that processes are set up in such a way that steps can be traced. We are therefore obligated to make everything traceable from A to Z. Said differently, we can look back in time to see which steps have been taken.

Have you thought about standards that are not adopted?
The biggest challenge for us is to make the process from project to production standardized. Once a customer reaches out to us, we start a 3 phase process to realize a series production process. First of all, we call it a project. The project becomes a prototype and the prototype eventually becomes a product, that will be produced in series.

Why is the standard not adopted?
A beginning was once made to standardize the development process but it has never been finished. The company grew fast and every new order from clients was and is still seen as a project. However, there comes a moment when it is no more project. We must then make a switch in our process from seeing it as a prototype to arranging it as a series production process. But our approach of developing a series production process is thus improperly addressed,

What developments are currently taken to improve the development process?
We are working on a standard interface that is almost finished.

Structured interview expert 2

What standards are currently used?
ISO 9001 is the common standard that we adopted over two decades ago. Later we became medically certified according to the ISO 13458 standard. We use the IEC 60601 standard to indicate that our machines are safe.

Furthermore, we work according to standard procedures, work instructions, and templates. Large customers, such as ASML, ZEISS, Thermo Fischer etc. impose also standards on us. They want us to be as coordinated as they are. Therefore, we feel pressure from those large companies. ASML uses for example GSA's. These are standard registration systems, and they demand us to adopt these standards as well. Furthermore, we are improving on Health safety, and Environmental procedures and we are working on competency management. These improvements can be seen as procedures and not per se as standards.

Which positive effects do you meet by those standards?
The ISO13485 is seen as a better standard than the ISO 9001. Therefore we are seen as a company that performs better than other companies that are just ISO 9001 certified.

Have you thought about standards that are not adopted?
We use a procedure to switch from prototypes to production. We also use a Lean Six Sigma method, the 5S method. However, the 5th S stands for standardization and that is currently our bottleneck. We are introducing and improving the NPI process, which stands for New Product Improvement. The NPI must improve the switch from customer demand to the production process. For the NPI, we must first inspect if the product can be made. Then, we develop a work instruction and start building prototypes. During the prototype phase, we order all the individual parts, produce a series to test whether the individual parts fit, and test the new software for the product.

ASML requires us to adhere to the glue standards. The customers that supply parts don't always deliver properly cleaned parts. Therefore we are considering to buy a cleaning facility.

Are you sure that products are compatible from the beginning, or are you making them compatible during the prototype phase?
Sometimes adjustments are made during the prototype phase. We don't see significant compatibility problems. The pilot phase follows after the prototype phase. During this phase, we try to arrange the production process in such a way that the new product can be produced in series. A work instruction will follow from the pilot phase and we eventually want a working product. Then we agree that the product is good and we are sure that the product meets the requirements and that it is compatible. A problem is however that all the work is done by employees and employees make mistakes. Steps are written down, but not always as good or complete. Still, we produce products for our clients and our clients are satisfied with our products.

What is currently a problem that you face due to a lack of standards?
All production steps are recorded in a TPD (technical Production Document). Once a TPD changes, our employees must change as well. Employees that must change are a challenge for our company.

We have products that are series production, the product hasn't changed, but the requirements have changed. To give an example: ASML introduced a new requirement which only allows us to have 0.15% damage on our product instead of the used 1.5% damage. Damage includes small dents and scratches. In the future, the damage may only amount to 0.015%.

Why is the standard not adopted?
I've internally heard that sometimes standards are not suited, because standards may differ per product. Clients demand different things and that makes it difficult to make standards and to work according to standards. The 5S method is intended to make this easier, but that's easier said than done. There are thus all kinds of mechanisms why we have not adopted standards.

Furthermore, there is always time to solve a problem, but there is no time to solve it at the root of the problem. For example, we can solve a scratched product by replacing the scratched part, but we don't look at how can we prevent scratches from happening.

Appendix B: Exploratory interviews

Exploratory interview expert 2,

I see that you use quite some more standards than just a view.
Yes, we have adopted over 300 standards, however, most of them are guidelines. We use those guidelines during the development of products. For example, the ISO 2768 standards is a tolerance standard. This is important during the development of a machine.

Why do you think GCpuSol has adopted these standards?
There are mainly three reasons for adopting a standard. These are the following:
The customers ask us to adopt a standard. The Product must comply with regulations and the environment in which our mechanics build machines, which is the cleanroom, must meet requirements. The Dutch health and safety regulations, better known as ARBO, impose standards on us.

When is decided to adopt a standard?
When we receive a quotation from a customer we often receive a list of standards that we must adopt. Then we check whether we have already adopted the standard, if not, we adopt it.

Is it difficult to adopt standards?
If a new standard is comparable with a standard we already use, than adoption is easily done. However, ASML currently asks us to step-up a scale in our degree of cleanness. Currently, we are cleanroom grade 2 certified, but ASML wants that we step up to grade 1. The difficulty for us is whether it is feasible for us to invest in it.

What are other reasons to adopt standards currently?
Currently there are no other reasons than the ones I already told you, to adopt standards.

What might be reasons to adopt standards in the future?
I would not know, the reasons I already gave will probably stay the same.

Are there problems when standards have to be adopted?
I can give an example when we critically thought about adopting a standard or not. One of our clients wanted our cleanroom to be adapted to a room with ionized air. Therefore we also had to adopt a standard to prove that we are certified. However, this standard is not relevant for us, because there is no reason to ionize the air in our cleanroom. It would be relevant is we produced microchip, however, we only make the machines in with which microchips are produced.

How do you define when a standard must be adopted or not?
We decide to adopt or not such a standard as the above given example, by looking at what other companies do and what is practically feasible for us. Finally will the audits of big clients point out if we must adopt such a standard or not.

Exploratory interview expert 3

I have seen that you have adopted over 300 standards.
As far as I know, we only use two standards: ISO 9001 and ISO13485.

But you also have, for example, adopted the IEC60601.
Yes, but other ISO numbers that we have adopted are only Guidelines. For example, the 60601 is a guideline for laboratory equipment. We don't use this standard that much; we only use it to indicate that we work according to guidelines and produce safe products. We only adopted these standards, which are more guidelines, because products must comply with requirements.

Why do you think GCpuSol has adopted these standards?
GCpuSol has adopted the ISO 9001 to demonstrate that we conduct business orderly and take it seriously. We use it as a guideline to set up certain activities within our company. In addition, it gives direction to your company and quality processes. We adopted the ISO13485 because we had the ambition and still have to produce medical products.

Must products for the semicon industry also adhere to the ISO 13485?
No.

Is it essential for other companies in the market that you have adopted the ISO 9001? For example, to indicate that you work in a structured manner?
I don't know if it directly attracts clients. It is more internally useful for our quality processes. Nowadays, almost everyone has adopted the ISO 9001. You can't differentiate yourself anymore in the market with the ISO 9001. Maybe once you start a company, you can differentiate yourself, but not anymore.

And is it for clients vital that you have adopted the ISO 13485?
Every company that does something with medical products must have adopted the ISO 13485. That is a requirement.

But you don't use the ISO 13485.
What do you mean?

Well, you don't produce medical products, as you said earlier.
We have some products that must adhere to the ISO 13485. But not as a legal manufacturer.

Do you have an idea how this adoption process is set up?
No, not really. We decided once that we wanted to build more complex products. And we have been looking for markets where there is a need for complex products. This market was the medical market, and from that point of view, we adopted the ISO13485 to produce medical products and get a foothold in that market.

Are there plans to adopt other standards?
As far as I know, currently not.

Are big players in the market pushing you to adopt quality standards, such as Thermo Fisher, ZEISS or ASML?
No.

So, the standards you have currently adopted are enough?
Yes, for our activities, it is.

Do you think standards are essential for your organization?
Our quality process is essential, and it originates from our quality standard. So in that sense, you can say the quality standard is important.

You were not present when the ISO 9001 was adopted, nor the ISO13485, but you were when the other standards you see as guidelines. How is this executed?
Which do you mean?

The guidelines such as ISO2859.
I'm not familiar with all these standards. But look at it like this, a product must meet guidelines. For example, it must adhere to CE. Whether we develop or sell products, the products must conform to the so-called blue guide. We must ensure that the product adheres to the blue guide if we sell it. The overarching framework of standards and guidelines within Europe tells which standards must be met per product.

When you notice that a product must meet specific standards, is it a matter of buying the standards?
Such a guideline only tells what the product must comply with. And we adopt those specifications to design or develop the product. Once we have developed a product, it is tested to whether it meets the guidelines. If not, then we adjust the product. We must contact notified bodies for some tests, which test a product or us and deliver a test report. That's how it works.

Do you think other standards will be adopted in the future?
Currently, I would not know which ones.

Can you think about a need for standards in the future?
No.

Exploratory interview expert 4

In many small businesses, standards are often seen as many obligations and usually don't support them. So in practice, people often do not work according to the guidelines. Luckily we see in our field and company that people are willing to work according to standards and procedures.

And that is the fundamental reason that you have adopted quality standards?
Yes,

And why specifically the ISO 9001?
I think the demand originates from the customer. Major customers require you to have the ISO 9001 to be able to supply them. In fact, the big, serious customers impose this on their suppliers. So that's where it starts. As a company, you pay for external companies to be informed. So there is a customer-supplier relationship to it. Companies also need to be audited, and when customers see that you do what you say and work according to your procedures, they can judge it as valuable.

Does a large customer such as ASML also pressure adopting a certain standard?
ASML pushes the limits even further. They demand suppliers, especially tier suppliers like us, to set up activities in a certain way. They educate their suppliers. And especially tier suppliers like us, we are the first in line. And yes, therefore, they impose standards on their suppliers. And we set standards for our suppliers.

Ok, so you pass those standards on to others?
We pass the standards on. You can compare it with the aviation industry. See it like this: only a few die in a car crash. When an airplane crashes, 300 people will die. The impact is bigger. So the aviation industry began to work according to major procedures and guidelines. Not only for maintenance but also to organize processes. A pilot, for example, must work according to extremely many procedures and can't come up with anything himself.

Do you see specifically within the semicon industry that other companies have standards that GCpuSol does not yet have and that GCpuSol , therefore, also adopts the same standards?
The customers help with this. But you also want to have a self-learning effect in an organization, so that we also learn from out our mistakes to prevent a repetition of faults. Therefore you need to have procedures to avoid a repetition of faults. That isn't easy because something new is added every time, and sometimes you are surprised.

And if we look specifically at the ISO 9001, why did you adopt specifically that standard?
ISO 9001 is the standard everyone begins with because that is THE ISO standard. So everyone works according to the 9001. So if the number would, for example, have been 9003, then everyone would have adopted that one.

There are different categories of standards: quality, compatibility, safety, and measurement. I believe compatibility is arranged between the companies by much consultation. No product enters the production room before you are sure it is compatible, right? Yes, we also impose standards on our suppliers. Every part that enters our facility must be extremely clean and free of dust. These parts are vacuum sealed, and they

can't have any scratches. One tiny scratch means disapproval. That does also credit to the sterile industry.

Within the semicon industry, do you think there is a trend of adopting standards?

Yes, ASML is imposing standards on their suppliers. However, ASML has also given us assignments with the intention that we make progress. Such duties trigger us to improve. Imagine that a company delivers worse than another, and then they impose standards on the less performing company to adopt. In this way, you adopt standards that other companies have already adopted. We also impose standards on our suppliers in this way.

Do you think belonging to a value chain will MoTivate adopting standards in the future?

It will only go on. Improvements are constantly happening.

Looking back at the standards. For example, a better quality standard arrives. Will you adopt it?

Yes probably we will, as long as it will lead to perfection.

Exploratory interview expert 5

Your primary standards are ISO 9001, and ISO 13485. The other standards are more or less seen as important guidelines during the development of products.
I want to know more about quality standards. For example, why do you think GCpuSol adopted ISO 9001?
Many customers demand that from us. I know companies that don't have the 9001, but they have processes. What you actually want is to record processes to guarantee efficiency and uniformity and, therefore, quality. The ISO 9001 is not a target itself, but it is a means. So if you do record processes, make sure you get that 9001 label on your window. That gives confidence to customers. The impact of the ISO 9001 is limited because everyone has it. But it is some sort of an entrance, a selection for a supplier whether you have it or not.
For the ISO 13485, this is different. We had the ambition to develop and produce medical products. Therefore we adopted ISO 13485.

Is the ISO 13485 seen as the primary standard for the medical industry?
No, there are also American standards and harmonized standards. The ISO 13485 is close to harmonized standards. However, American demands sometimes more strict standards than the ISO 13485. The 13485 was a strategic choice, we wanted to distinguish ourselves in the market, and we were one of the first with that standard.

The reason for adopting the ISO 13485 was to distinguish yourself, not because companies demanded you?
One company demanded us, and that triggered us to adopt it. This company wanted to produce a specific product, and they asked us to develop it. Therefore we adopted ISO 13485.

Looking at standards in general, does it occur that an employee with a particular function proposes GCpuSol adopt a specific standard?
The degree of cleanness is standardized, which applies to the cleanroom. We have a cleanness employee who sometimes asks us to adopt a standard so that we know the requirements. There is a distinction between norms and standards. You automatically adhere to the standard when you produce something according to a norm. When needed, we also buy a norm. For example, a norm tells us how a circular saw must be used. And we also adopted ESD norms or the EC60601. When you develop something, the product must meet the guidelines. Therefore, we buy norms that tell us which norms must be included during the development of these products. We produce, for example, a phot laser plotter which had to comply with UL (Underwriters Laboratories). According to their definition, it is an office machine. So we had to adopt the norms that are compliant with office machines.

Is it also a reason for you to adopt standards when the market has some standards that you have not yet had?
Almost always, adoption follows from customer requirements for which we develop machines. The client wants something. For example, CE certification and then we must look at the norms that adhere to the CE requirements.

When a new standard enters the market, that is better than the 9001 or 13485. Is that for you a reason to adopt it?
That is not easy to say; it depends on why the new standard enters the market. When we need a standard, then yes, we will. For example, when a new version of the ISO 9001 arrived, the 9001-2015 that replaced the 9001-2008, we had to adopt it.

Why do you have to adopt a new standard?
If we want to develop something new, we must adhere to the newest standard.

And is it also the case that big customers such as ASML impose the new standard on you?
They might say a company must adopt a standard; otherwise, you are out of business for them.

Is it also a reason to adopt standards in the future to stay relevant in the market?
Yes, you have no choice. However, with some standards that big companies impose on us, we look at the complexity of adopting it compared to our benefits. For example, we wanted to adopt some standards to certify a specific machine. However, it was too difficult to adopt these standards. Therefore we could not certify the machine.

When a new company enters the semicon industry, what would be the reason to adopt standards? Would it be a reason for them to adopt standards to overcome insecurity?
It depends on the standards. You must have CE standards on your product. ISO9001 is only a requirement from customers. However, ISO 13485 is a hard requirement. You can only produce medical equipment when you have adopted ISO 13485.

It is a reason to adopt standards when others have them?
Let me think, yes, the environment standards ISO14001. More and more companies are adopting it. So we will adopt it in the future as well. IT depends on the market dynamic whether we adopt a standard or not.

Appendix C: BWM interviews

BWM interview expert 1

What is the most important category?
External stakeholders are the most important. Otherwise, you cannot join the market. This category triggers whether you adopt standards or not. Then organization characteristics are the most because they must adopt, and the least important is the perceived characteristics of ISO standards. External stakeholders will indicate whether a standard must be adopted. Internal stakeholders will indicate how we must adopt it. The most challenging part of adopting the standard is finding out how everyone will accept it within the organization. The most challenging categories for adopting quality standards are organizational characteristics and perceived characteristics of ISO standards. All three categories are essential for adopting quality standards.

What is the most important factor from the first category?
Government pressures because we must meet legislation. The customers are almost as important. Mimetic pressure is the least important. Customers and big players are equally important. We do not feel much pressure from suppliers. First, we must have customers before we can feel pressure from a big player. As a company, you are working towards attracting customers.

What is the most important factor from the second category?
Management support. The least important is centralization. These two factors can only work against each other. The difference between those is max, I have never seen those two factors working well together in a company. Formalization is also important. Somewhat equal to management support. Organization size is not important because it does not matter whether the company is small or large. Both centralization and organization size will be ranked with a nine. But those nine's are different. Centralization and management support are not working together. And organization size just doesn't matter. Formalization is a whole lot more important than centralization.

What is the most important factor of the third category?
Complexity is what many companies struggle with. The least important is relative advantage. The success of a standard depends on its complexity for adoption. Complexity and compatibility are somewhat equal. When a standard is compatible with others, it will be less complex to adopt it.
Complexity is very strongly more important than relative advantage.

Now that you have seen all the factors, which factor do you think is the most important?
I think legislation is very important. Thus, pressure from the government and then pressure from customers will follow. So those two factors are driving us to adopt quality standards, and the other factors are factors that will make it a success or not.

BWM interview expert 2

What is the most important category?
The first one

And the least important?
I find that difficult.

Ok, we can also first have a look at all the factors and rank the factors themselves.

What is the most important factor in the first category?
What is, according to you, the difference between a customer and a big player?

Good question, a big player is the end customer for who most companies are working—for example, ZEISS, ASML, and Thermo Fischer. A big player can be chosen, while a customer cannot be choosen.
ZEISS and Thermo Fisher are for us big customers, and they are working for Intel, and they are on the same level as ASML. Big customers are the big players for us, but it does not matter whether we are directly or indirectly delivering to them. For example, a customer to which we directly deliver is VDL, and VDL is, for us, also a big customer. There is a difference for us between a small and big customer. Let me give an example. Imagine we make a product for customer A, which is a small customer for us. But customer A delivers to a big player, and the big player is not our customer. Then we would only do what customer A demands and not what the big player demands. Of course, what the big player demands from customer A will also be transferred via customer A to us, but we do not do what the big players demand in the first instance. Only when the big player becomes a customer of us.

So the pressure from customer(s) is the most important factor. Only direct customers are important for us, not the big players to which we do not directly deliver.

Do you mean with pressure from the government that they impose legislation?
When the government exerts pressure, they impose mandatory legislation on you.
Well, then the government is the most important. Because we must act as a legal company. When you receive your salary, you have to pay tax.

Does the government also impose mandatory quality standards on you?
The government would not impose the ISO 9001 on companies. However, the medical device regulation is a law. Companies like us, who produce medical devices, must have adopted a medical quality standard. So therefore, we adopted the ISO 13485.

And what is the least important?
Mimetic pressure. Customers are as important as the government. Big players are also very important but not as important. Pressure from suppliers is also important.

Can you give an example of when suppliers are imposing pressure on you?
Yes, they have a certain way of working that produces a result. That is their standard process—for example, the production of PCBs. We deliver a scheme and demand them to produce it in a standard way.

Ok, but then you are imposing pressure on the suppliers.
Yes, but the suppliers also say to us what they are capable of, so we must sometimes change our design so that they can deliver what we produce.

And those suppliers are also imposing quality standards on you?
Yes for some things they do.

Why are suppliers Somewhat between Equal and Moderate thane Mimetic pressure?
Because I think that our value chain is more important than that of a colleague company.

What is the most important factor in the second category?
Management support is the most important. Adoption will only happen when they want to adopt it.

What is the least important factor?
Organization size, when a company becomes very large, you must centralize and formalize. And when a customer imposes a standard on you, it does not matter whether you are small or large. You must adopt it. It does not matter how small or large a company is, management support will always make the decision to adopt or not. Formalization is interesting because the question is whether we want to work according to rules. Actually, we are a bunch of technical people that see it as a must to adopt standards to do what we like. Centralization is needed to support the management team, especially when a company grows. Formalization is more important than centralization because formalization is about writing down the rules and centralization is about controlling the company from a central point.

What is the most important factor in the last category?
Relative advantage, because only when we think a quality standard will bring advantages we will adopt it.
Complexity is the least important factor.

Imagine that you could only keep doing business with a customer by adopting the standard that they impose on you, but adoption is complex. Would you still adopt it?
Yes, we would do our best to adopt it even when it is very complex. If it means that we must change our company, then we will still do it, because we need the standard to stay in business.

Was it difficult to adopt the ISO 9001?
Adopting ISO 9001 was not difficult. ISO 13485 was, on the other hand, difficult to adopt. We looked at the advantages and complexity, and differences of adopting it. We decided that we were capable of adopting it, so we did.

What is the most important category?
Characteristics of the external environment is the most important category. The least important category is organizational characteristics. I think perceived characteristics of quality standards is also important because the characteristics that a quality standard offer are important for adopting it.

I have a question about mimetic pressure. You still think that mimetic pressure is somewhat important?

When we are in trouble, we will look at other companies and what they are doing. Our performance is also compared with the performance of other companies. When we would perform poorly, we would copy companies doing better than us.

BWM interview expert 3

What is, according to you, the most important category?
The 9001 is a sort of a must-have standard in our industry; that's why we have adopted it.

And when you have to choose between those three categories, what is the most important?
None.

Ok, let us first look at the factors from the first category. What is then the most important factor?
You will not get an assignment from a big company such as ASML when you do not have the ISO 9001. ISO 13485 is also externally determined. The bottom line is that you must have the ISO 9001 and ISO 13485 to do business in this industry. The most important factors are, therefore, the customers and big players.

Is there a difference between smaller customers and a big players?
In the industry, it is a standard to have the ISO 9001.

That is not an answer to my question.
No, because I cannot answer your question. In the industry, you must have the ISO 9001 to do business.

What is, according to you, the least important factor?
Normative pressure.

Do you think pressure from the government is important?
No, because we are a commercial company. The same account for non-governmental organizations. The company that pays us to do business is the most important.
Suppliers are also not important. They are not exerting pressure on us to adopt quality standards.

How much more important in pressure from the government than normative pressure?
If the government would impose it then it is 100% more important. It would then be a license for doing business. It is straightforward; you are out of business if you do not follow the government's rules.

The rest of the factors are also not so important, mimetic pressure is for example also not so important, and the same accounts for pressure from suppliers.

What is the most important factor from the second category?
None, because customers impose the standards.

Ok, but clients are not involved with this category. SO you must choose between those four factors. And according to the scientific literature, these factors are relevant.
That is good for the literature.

According to your colleagues, these factors are also relevant, so what would be the most important?
Ok, but in my experience, we adopt these standards because customers want us to adopt them.

Yes, if I am correct, that means that you want to work according to rules, right?
Then I would say formalization is the most important factor.

And the least important factor?
Management support

How much more important is formalization than management support?
100%

And formalization than centralization?
50 / 50, I also think that the size of the organization is also important. But it is not that different from formalization.

What is the most important factor from the last category?
It is all about money. Money is the driving factor. If a standard causes many problems, it will not be adopted. So I think Relative advantage is the most important factor.

What is the least important factor?
Complexity, because we must adopt it when the customer demands it. Even if adoption is very complex.

We still need to rank the categories. Now that you have seen all the factors, what is the most important category?
The first category is the most important. The least important category is the third category. However, the difference between the first and second and third categories is maximal. Characteristics of the external environment is absolutely more important than organizational characteristics and perceived characteristics of the quality standards.

BWM interview expert 4

What is the most important category?
That is a difficult question because the reason for adopting it can depend on the stadium of a company.

I can imagine with the first category that pressure is exerted by the government when a company is working for the government. A private company only has this pressure from the government when they must meet legislation, but not when they have to do business with the government. The government can determine whether to adopt quality standards or not with its criterion. This is the first that comes to my mind in the first category.

The last one I find difficult.

Ok, I can also show you the factors that belong to the last category so that it becomes more clear.
What is the most important factor of the last category?
Relative advantage, without the ISO 9001, you cannot be part of the ASML chain. You will not get assignments to produce machines for ASML, because ASML will not do business with companies that have not adopted the ISO 9001.

What is the least important factor?
That is difficult. Can we also rank some factors the same?

Yes, we can do that after you have decided what the least important factor is.
I would say compatibility because standards are often linked to each other. When a standard is not compatible, it will not be adopted. The complexity of adopting a quality standard t is not that important; you must adopt it to do business. Even when adopting I difficult.

Now, let us rank the factors from the first category. What is the most important factor?
Pressure from customers**,** however, the government can also be a customer. Nevertheless, now let us assume that we are a commercial company.

And what is the least important factor?
Normative pressure.

Why is pressure from the government equally important?
When I think about working according to hygiene norms, working sterile is demanded by the customer and the government.

And that also applies to quality standards?
Yes, in my opinion, it does.

Why are big players not equally important to customers?
Well, you can choose the big players with whom you want to do business with

Pressure from suppliers is not that important; usually, customers impose pressure on their suppliers.

Mimetic pressure is somewhat important. Of course, most companies trust in their own capabilities, but you do not want to differ that much from other companies.

In the semicon industry, the adoption of quality standards is mainly exerted by pressure from customers instead of copying other companies.

What is the most important factor in the second category?
Management support by far.

And the least important factor?
Size of the organization does not matter whether you are a small or large company. When customers in this industry impose standards on you, you must adopt them.

Management support will always be the most important factor. You cannot do it when the management team does not support the adoption.

Formalization is also very important because we want to work according to rules. So that is really what matters.

And how does this refer to the adoption of quality standards?
The success of adoption depends on management support. If your management support is well organized, then centralization is less important. When a company is not well organized and bad centralized, actors might exert less pressure on performing their responsibilities, which reflects a low degree of formalization. Centralization is then important to establish formalization. Larger companies might decide to centralize to keep their activities organized. A small company might decide to decentralize and give some actors much responsibility.

Formalization becomes more complicated when an organization grows. However, formalization is as important as the factor' organization size'. It does not matter whether you are a small or large company; you want that your processes are properly organized.

Now that you have seen all the factors. What is the most important category?
Category 2, organizational characteristics, because that is who makes the decisions

And what is the least important category?
Category 3, perceived characteristics of quality standards. However, the difference between those three categories is not that big. They are all three very important for adopting quality standards.

BWM interview expert 5

What is the most important factor in the first category for the adoption of quality standards?
Customers

And the least important factor?
Pressure of suppliers

The government is not demanding from us to adopt quality standards.

What is the most important factor in the second category?
Management support

What is the least important
Centralization

I think management support is as important as formalization.

What is the most important factor in the third category?
Relative advantage

I find complete very important as well. When it is too complex to adopt the standards we will not adopt it.

What is the least important?
Compatibility

What is the most important category?
Pressure of (external) stakeholders

And the least important?
Perceived characteristics of quality standards

BWM interview expert 6

What is the most important category?
The first one

And the least important category?
The third one.

What is the most important factor in the first category?
Pressure from customers is the most important. They impose standards on us.

What is the least important factor?
Mimetic pressures, because we do look what others do. But we do not feel insecure compared to them.

Do you think mimetic pressure plays a bigger role when a new organization enters the market?
Yes.

Does the government impose pressure?
No, they do say that you must have a standard, but they don't indicate which standard.

What is the most important factor in the second category?
Formalization.

What is the least important factor?
Organization size, because it does not matter whether the organization is small or large.

What is the most important factor third category?
Relative advantage.

What is the least important factor?
Compatibility. We can do things at the same time in theory. On the other side, when something is demanded from us, then we will work towards a solution to make it work with another standards when this would be a problem.

BWM interview expert 7

What is the most important category and the least important?
Perceived characteristics of quality standards are the most important category. I do not think ISO 9001 is a good standard. ISO 13485 is, in my opinion, a good standard. I think characteristics of the external environment is the least important category.

What is the most important factor in the first category?
I think normative pressure because we impose much pressure to adopt standards on ourselves.

What is the least important factor?
Pressures from non-government organizations.

Customers are somewhat equal to big players. They can both impose standards on us. We don't feel a lot of pressure from suppliers.

What is the most important factor from the second category?
Management support

And the least important factor?
Centralization

Management support makes the decision, and we noticed that our management team was pushing to improve the quality to prevent disapproval of products. We had many processes, so we had to formalize them, but because our organization is small, many processes were not organized. When we start to grow, formalization will become increasingly important, but the increased complexity of the company will then oppose the implementation. It will cost more effort to adopt standards when we start to grow.

What is the most important factor in the last category?
Relative advantage is the most important. The least important is complexity.

We made a presentation with our procurement department for our suppliers because they find it very difficult to meet our increasing demands and requirements. The requirements in the semicon industry are starting to look like that of the autoMoTive and medical industries. We are presenting to our suppliers the increasing complexity of the production processes. If you like it as a company, you can keep existing. Processes need to keep improving because the customers are demanding it from us. As a company, you join, or you are out of business.

BWM interview expert 8

What is, according to you, the most important category?
The organizational characteristics, because you are internally MoTivated to guarantee that your processes are executed correctly as a company. You are, as a company, not doing it for someone else. Sometimes, customers like ASML impose standards on us. Then it is an advantage that we have already adopted. However, in the first instance, we have adopted the ISO 9001 for our own sake.

What would be the least important category?
The third category: Perceived characteristics of quality standards. When we adopt a standard, we will do it for a customer because we must deliver our products to them.

How much do these categories differ from each other?
They are completely apart, as much as possible. But nevertheless, that is my opinion.

What is, according to you, the most important factor from the first category?
That would be the customer and the big player because when we deliver our machines to the company VDL, then they deliver it to ASML, and ASML is the end customer. So customers are as important as the big players.

And what is, according to you, the least important factor?
The other factors are not so important according to me. I do not think the government or the ISO company pressure us. Perhaps we experience a little bit of pressure from suppliers. Mimetic is not important. We are not copying other companies out of insecurity. So I think mimetic pressure is the least important factor.

What is, according to you, the most and least important factor from the second category?
Formalization is the most important, and centralization is the least important.

And why these two choices?
Because I think you have to record your procedures and rules to clarify how you do things. It does not matter how this pressure is exerted. Therefore I think centralization is the least important.

Do you think the size of a company matters for adopting quality standards?
Yes, because you have to organize your processes more clearly when you are larger.

What is the most important factor from the last category?
These factors are difficult to differentiate because we already have two quality standards. The second quality standard was adopted because we wanted to do business in America. We had to adopt the ISO 13485, which had to be compatible with the ISO 9001. Compatibility is, therefore, the most important factor. Observability is the least important factor. Compatibility is somewhat as important as relative advantage.

BWM interview expert 10

What is the most important factor in the first category?
The quality standards have once been developed and someone said that companies in this industry must adopt it. Pressure from the customers is the most important.

What is the least important factor?
The non-government organizations. Mimetic pressure is not important for us. We really want to do things independently, without copying others. Nongovernment organizations once said to us to stop consuming so much plastic. So they meddle with our industry.

What is the most important factor in the second category?
Management support. The company itself has the final word to impose a standard or not.
I see formalization as finishing what you have started. I don't see it as a reason to adopt standards.

What is the least important factor?
I find organization size interesting. Because, when you are small it is difficult to adopt standards. At this moment is would say organization size is the least important factor. If we would only be with 30 employees, then the mechanism that the factor organization size describes would be important to adopt standards to grow.

What is the most important factor in the third category?
A salesperson would say relative advantage and a quality person would say complexity.
I think within the market, relative advantage is the most important factor.

What is the least important factor in this category?
Compatibility

What is the most important category?
pressure of the external environment

What is the least important category?
Perceived characteristics of quality standard

Appendix D: Follow-up interviews

Follow-up interview expert 2

Do you think you, as a company, can influence the factors?
This is a sort of field of forces, the factors. For example, when our new managing director finds something fundamental, it will happen.

There is a confirmation between the factors. When our customers impose standards, our management team will then also find it important. If we don't listen to our customers, we will have a negative relative advantage compared to our competitors. So there is a correlation between the factors. The factors are not isolated.

Some factors, such as pressure from non-government organizations. That somehow happens to the company. Their pressure can only minimalistic ally be affected. We try to influence it by being part of all kinds of organizations, including these external companies. But it is not the case that we sit around the table to discuss with all the big players what the strategy will be in ten years. We are aware of our position so to say.

So, according to you, the pressure from big players can't be influenced. Because their pressure will always be transmitted through other companies?
You can decide not to do what they demand, but you will not have them as your customer. We are not on the level that decides which standards to adopt. The companies on that level, are sort of protected in the market.

Looking internally, we can try to influence our customers. But when decisions are made on a corporate level at ASLM or ZEISS, it will be unable to have an influence.

These companies are the domain experts and the end-users. They have the most knowledge. They are also much bigger than us. Our employees are generalists, and their employees are specialists.

Is there a factor that can be influenced ?
In the end, people are the ones who do things. You can write a lot of things down, but people must be convinced. If we are talking about changing things, you write down a process. But the human being must do it. So having an influence on change must be human-related.

So influencing these factors is somewhat possible?
Yes I think so. Not by imposing more pressure on the customers, but by having a conversation with them. The chance of change is in the relationship and the soft skills.

And so this applies to the most important factor?
Yes, you can discuss the form of the standard but not the content.

Can you influence the pressure from the government?
No, not that much, because we must act legally. We can only exert a little bit of pressure via labour unions.

Can normative pressures and management support be influenced?
Yes, we had a lot of training towards LEAN, which includes standardization. When we grow more, it becomes more important to write down and capture processes and thus standardization.

What about mimetic pressures?
We are working on scaling down organizations' teams and which can be scaled with KPI's. This makes it easier to compare the teams with each other.

Ok, but what I mean is that you are already working for over 20 years with quality standards. You were among the first to adopt them and have not looked at other companies. Do you think mimetic pressure is more important for small, new companies in the industry?
Well, I can give an example of how this pressure applies to us. We are working towards building more complex and bigger machines. Standards will therefore also become more complex. If we want to compete with the same companies on that level, we must look at how these other companies do so that we can improve on them.

Complexity is not an important factor.
Yes, for us, is the factor complexity not a big problem. But for the smaller companies that deliver to us, the complexity of adopting quality standards is an issue. This is because they have fewer employees, and it is, for these smaller companies, therefore, more difficult to manage many processes, which one employee often does.

Relative advantage is related to pressure from customers. Because when they see the advantage of adopting a standard, and we don't, we will still adopt it.

Follow-up interview expert 6

Can you influence the factors?
The amount of influence that we can exert is pretty low. Customers are demanding something from us, and we must adhere. The customers are challenging us and putting us under pressure to deliver machines compliant with the quality standards. So the influence is very low.

Imagine that a customer tells you to adopt a new quality standard. Can you exert influence on that demand?
Yes, when they ask us, we can. But many standards have been adopted for years, and then exerting influence becomes very difficult.

Ok, but when a customer demands you adopt a new quality standard, how can you exert pressure?
Imagine a new ISO xyz that applies to our business has been developed. Then we will also look at whether it is compliant with our business model.

So the importance within the organization also plays a significant role?
Yes

And do you think you can influence the pressure of customers by having a conversation with them?
Well, the standard will not change anymore. But we can talk to them about timing and costs and that kind of things.

So you can discuss the execution?
Yes

What will happen when you don't adopt the standard they impose on you?
You run the risk of losing the customer. That risk is significant.

I was thinking about that too, but I was wondering if customers also depend on you. You hold a small monopoly position with the production of some machines that other companies are not producing, right?
Yes, at the moment we are the only manufacturers of some machines. But nothing is impossible. Production can always be moved.

Is there another factor on which you can exert pressure?
Well, most of the factors are operational and not normative.

So once a standard must come, it will come, and a lot of influence cannot be exerted?
Yes

Can you exert pressure on the government?
No

And non-governmental organizations?
I know there are lobbies and things like that.

And with lobbies, you mean representatives?
Yes, but I am not sure if we are also involved. But probably someone in the semicon industry is involved.

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Can the factor be influenced?
Well, it depends. I am very much of the bottom-up, so employees within the company indicate something. That leads to organizational characteristics. Internal pressure might lead to adopting quality standards to serve the customer better. I believe in this mechanism.

What happens when a customer reaches out to you and imposes a new quality standard on you. Can you influence their pressure?
Yes, of course, I think that we, as GCpuSol , are very critical of what our customers demand from us. We will always check first if we need the standard and what it will bring us.

And do you still have a choice if customers no longer want to do business with you if you don't adopt the standard?
That is a difficult one.

Also, taking into account that customers are dependent on your machines.
It depends. It almost looks like a sales pitch. It can be a bluff, so they buy somewhere else machines. On the other hand, we don't want to lose production, so we will always keep in conversation with them and maybe look less critical of their pressure.

So you can affect pressure from customers by talking to them?
Yes, absolutely. Yes. For example, no discussion will take place when a standard already fits within our way of working. However, when the organization needs to change a lot but we will keep our turnover with that, it is worth the investment. The exit point is that it must be worth the cost-benefit. Otherwise, we will give the blow to the customer and tell them to forget it.

Is it possible to dodge the pressure from big player(s)?
If we don't feel a need to do business with big player(s) and thereby adopt their standard, then we will not bring them in as our customers. It can be a challenge, and it can be good to broaden the company profile. When we want to do business in new industries and attract new customers, but a necessity is to adopt a new quality standards we will probably do it then. So it, again, depends.