

	•	. .	-	
Master	Ot.	SCIDI	100	Ι η Δεις

Graduation Committee

Chair

Prof. Dr. Ir. P.M. Herder

First supervisor

Dr. T.E. van der Lei

Second supervisor

Dr. M.L.C. de Bruijne

External supervisors - Grontmij Nederland B.V.

Dhr. H. Bruinsma - Principal Consultant Systems Engineering and Asset Management Dhr. C. van Buuren – Consultant Transport & Mobility





Erik Gaarenstroom - 1352067 j.h.gaarenstroom@student.tudelft.nl September 2014

Preface

This report presents my master thesis research, which I have carried out over the last seven months as an integral final project of my master studies Systems Engineering, Policy Analysis and Management at the faculty of Technology, Policy and Management of the Delft University of Technology. The thesis contributes to the knowledge on impact of asset management and asset management systems.

I would like to thank Grontmij Nederland B.V. for the opportunity to let me carry out this research and all members of the AMC team for their willingness to dedicate time and effort, to share ideas and to help whenever I asked for it. It has been a valuable experience to get a taste of the company and the culture in De Bilt.

This research has challenged me on many different areas and significantly contributed to my personal development. I would like to specially thank all the members of my graduation committee for their assistance during my thesis research:

- Hans Bruinsma Senior advisor systems engineering and asset management for your guidance throughout the project, for the extensive knowledge on the application of asset management and the sharp analyses when I got stuck in the thought process.
- Coos van Buuren Consultant transport and mobility for being my mentor and all the day-to-day support, for your enthusiasm and your formal and informal advice.
- Paulien Herder Professor at the section Energy and Industry of the faculty Technology, Policy and Management of the Delft University of Technology, for your sharp and to-the-point questions and remarks during meetings and your profound advice.
- Telli van der Lei Assistant professor at the section Energy and Industry of the faculty Technology, Policy and Management of the Delft University of Technology – for being my first supervisor and spending hours in the coffee chamber answering all my questions, for your time and dedication to my work.
- Mark de Bruijne Assistant professor at the section Policy, Organization, Law and Gaming of
 the faculty Technology, Policy and Management of the Delft University of Technology, for
 joining my graduation committee just before the kick-off meeting and the time you have taken
 to help me setting up the thesis in a scientifically sound manner.

Thank you all!

Erik Gaarenstroom

Amsterdam, September 26, 2014

Summary

In the beginning of 2014 the International Standard Organization launched the first version of the ISO 55000 series on asset management, which describes the requirements for an asset management system. The ISO claims important benefits for organizations implementing the ISO 55001, but empirical research to support these claims is lacking. This research establishes the most important impact factors of an AMS in terms of the positive and negative effects of the system. Also, the research provides insight into what is to be expected from the implementation of an asset management system in terms of the challenges and critical success factors. Finally, the research attempts to determine what specific aspects or company values of an organization are influenced by the AMS.

The main research question was formulated: "How to create insight in the impact of implementing an asset management system (AMS)?" Based on extensive literature study on the impact of management systems in general and a context study of the sector of power and gas grid operators, the term impact has been defined as the influence of impact-factors in five categories (motivations, challenges, positive and negative effects and critical success factors) on four general company values for grid operators (reliability, safety, public image and regulatory requirements) and on three preconditions for existence of almost any organization (employee satisfaction, organizational effectiveness and financial efficiency).

Possible impact factors have been identified from the literature study and provided the input for a questionnaire. Triangulation of results from semi-structured interviews with Dutch grid operators, Dutch survey respondents and foreign survey respondents produced lists of most relevant impact factors of implementing an asset management system for operators of power and gas grids in all five categories. The most relevant positive effects influence the organizational effectiveness of the organization by clarification of roles and responsibilities and improved transparency. Negative effects are the unexpected amount of time and effort and the friction among and double work for staff members due to the restructuring. Working up the quality of data on the assets together with realizing the necessary cultural changes have been the most relevant challenges for the grid operators and therefore effective leadership and ensuring commitment of all employees involved have proven to be the most relevant critical success factors.

Overall, the grid operators are satisfied with the impact of implementing the asset management system. Interesting conclusions from these results include that although increases in financial and asset performance in terms of increased reliability and safety as a result of implementing an AMS are claimed by the norms, the results of these research do not unambiguously support these claims. In a next step to quantitatively measure the impact of an AMS, research or organizations should instead focus on measuring the increase in organizational effectiveness, with the reduction of time in management meetings spend on investment decisions and the investments saved or made due to the increased insight into asset-related risks as potential performance indicators.

Also, the effect of time on the relevance of positive and negative effects seems limited over a period of about eight years. This might indicate that, due to the long lifetime of the assets in this sector, some effects take even longer to surface. Finally, the research support the claim that Dutch grid

operators are relatively mature in asset management knowledge and procedures compared to most foreign grid operators.

Most conclusions of this research are based on the perception of representatives of grid operators. As responses to the international survey came from all over the world, differences in definitions of asset management and asset management systems as well as differences in maturity in the concepts will have influenced the results. Furthermore, the respondents have positions in different departments and layers of their organizations and will therefore have rated impact from different perspectives, which will have also influenced the outcomes. Finally, the interviewed asset managers are promoters of the systems within their organization and might therefore be somewhat biased in assessing the relevance of asset management systems. Because of these reasons, the results and conclusions should be adopted with care.

As the results point out that the positive effects of the system mainly influence the organizational effectiveness, which is an aspect that is mainly used by public organizations (Richard et al., 2008), further research should focus on the commercial impact of the system. Applying a similar methodology in a more private sector will create insight into the commercial value of an AMS. Also, in order to substantiate the findings in this research, further research should focus on analyzing statistical data. Because of the public character of the sector, a lot of data on the performance of the grid operators is available and analysis of this data could provide an objective contribution to assessing the impact of asset management systems.

Contents

G	raduat	ion Co	ommittee	2
P	reface.			3
Sı	ımmar	y		4
С	ontent	s		6
1	Intr	oduct	ion	9
	1.1	Asse	et Management (AM)	9
	1.2	Asse	et Management Systems (AMS)	. 10
	1.3	Rese	earch Problem	. 10
	1.4	Rese	earch Context	. 11
	1.5	Rele	vance and Originality of Research	. 11
	1.6	Rese	earch Objectives	. 12
	1.7	Rese	earch Questions	. 12
	1.8	Rese	earch Approach and Report Outline	. 13
2	Ma	nagen	nent Systems: A Literature Study	. 14
	2.1	Defi	nition of a management system standard	. 14
	2.2	Турі	cal implementation process of a management system	. 14
	2.2	.1	Implementation Process Versus Certification Process	. 15
	2.3	The	content of a management system standard	. 16
	2.3	.1	ISO 55000	. 16
	2.4	Impa	act of Management Systems: A Literature Review	. 18
	2.4	.1	Different Categories of Impact Factors	. 18
	2.4	.2	Definition of Impact Resulting from Literature Study	. 19
	2.5	Poss	sible Impact Factors Resulting from Literature Study	. 20
	2.5	.1	Sub-categorization of Impact Elements	. 21
3	A S	ector :	Study: Power & Gas Grid Operators	. 28
	3.1	Choi	ice for a Sector-Specific Study	. 28
	3.2	Pow	er and Gas Grid Operators in the Netherlands	. 28
	3.2	.1	Increasing Pressure on Grid Operators	. 28
	3.2	.2	Early Adopters of Asset Management Systems	. 29
	3.3	Impa	act of an AMS at Dutch Grid Operators	. 30
	3.4	Defi	nition of Impact Based on the Context	. 31

4		Rese	earch	Methodology for Determining Impact	32
	4.	1	Sem	i-structured Interviews with Dutch Grid Operators	32
		4.1.1	L	Interview Methodology	32
		4.1.2	2	Approaching the Interviewees	33
		4.1.3	3	Interview Results	34
	4.	2	A Su	rvey Among Dutch and Foreign Grid Operators	34
		4.2.1	L	Survey Methodology	34
		4.2.2	2	Developing the Survey	35
		4.2.3	3	Approaching the Respondents	35
		4.2.4	1	Survey Results	36
	4.	3	Valid	dation of Results	36
5		Impa	act of	f Implementing an AMS	38
	5.	1	Com	parison of Impact Factors Resulting Interviews and Literature	38
	5.	2	Impa	act Factors Resulting from the Dutch Survey Respondents	43
	5.	3	Com	parison of Impact at Dutch and Foreign Grid Operators	48
	5.	4	Com	parison of Highest Ranked Impact Factors	53
	5.	5	A Vis	sualization of Impact of implementing an AMS	56
		5.5.1	L	Positive Influence of the System on Company Values	57
		5.5.2	2	Positive Influence of the System on the Preconditions	57
		5.5.3	3	Negative Influence of the System on Company Values	58
		5.5.4	1	Negative Influence of the System on the Preconditions	58
		5.5.5	5	Influence of Transition on the Organization	58
	5.	6	Valid	dation of Results on Impact of Implementing an AMS	59
		5.6.1	L	The Effect of Time on Perceived Impact	59
		5.6.2	2	The Effect of Time on Asset Performance	60
		5.6.3	3	Impact of Implementing an AMS from Different Perspectives	61
6		Cond	clusio	ons and Discussion	63
	6.	1	Cond	clusions of research based on Research Questions	63
	6.	2	Impl	ications of Conclusions for Asset Management Community	65
	6.	3	Refle	ections on Methodology and Conclusions	66
	6.	4	Reco	ommendations for Further Research	68
7		Refe	rence	es	69
Αı	าท	ex A:	An E	xample of a Risk Matrix	75
Αı	าท	ex B:	Impa	ct of Management Systems Literature	76

Annex C: Impact Factors Retrieved from Literature	79
Annex D: A Filled In Interview Format	90
Annex E: The Survey	95
Annex F: Overview of survey Respondents	101
Annex G: Differences between PAS 55 & ISO 55000	102
Annex H: Impact Overviews of Dutch TSO's/DSO's	103
Annex I: Effect of Time on Impact of an AMS	108
Annex J: List of Abbreviations and Definitions	110

1 Introduction

The American mechanical engineer Frederick Taylor was one of the first to investigate management processes and procedures according to scientific methods. Taylor applied an engineering solution to management issues with the objective to improve economic efficiency (Benschop, 1996). Taking over best practices instead of 'reinventing the wheel, over and over again', can be a way to make management more efficient. In other words, successful management practices are regularly standardized in order for other managers to apply them as well. Since Frederick Taylor, many management processes and procedures have been caught in standards, on an organizational scale but also on international scale. These standards, or norms, describe a framework of processes and procedures: a management system. Such standards are also applied to asset management, which is the subject of this research.

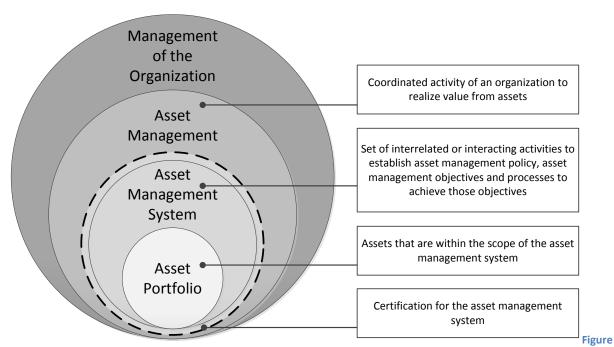
This research assesses the impact of implementing an asset management system at power and gas grid operators. The research relates to the context of management sciences, within which aspects of management are analyzed according to scientific methods.

1.1 Asset Management (AM)

Asset management is given a wide variety of interpretations throughout industries and even within a single company it may change (Morton, 1999). Amadi-Echendu et al. define engineering asset management as the total management of physical assets, as opposed to financial assets, whereby the financial and engineering systems are integrated with the human dimension (Amadi-echendu et al., 2010, p. 1). This definition seems to focus on the integration of finance, engineering and the human dimension and the authors call this integration organizational synergy. Another definition is given by Mitchell in his book Physical Asset Management Handbook in 2002 and is formulated: "Asset management in a comprehensive, fully integrated strategy, process and culture directed at gaining greatest lifetime effectiveness, value, profitability, and return from production and manufacturing equipment assets" (Komonen, 2012, p. 49). This definition also uses 'integrated' in their definition, but Mitchell emphasizes the importance of the aspect of the life cycle of assets in asset management. This is confirmed by another definition, used by Kostic in his paper on asset management in electrical utilities: "The process of guiding the acquisition, use and disposal of assets to make the most of their future economic benefit and manage the related risks and costs over their entire life" (Kostic, 2003, p. 275). Whereas the first two definitions talk about total management and a fully integrated strategy, Kostic seems to approach asset management more as a process per individual asset and not as a type of management that is fully embedded in an organization. This type of asset management is getting more and more outdated when considering more recent literature on asset management developments and definitions (Komonen, Kortelainen, & Räikkönen, 2012; Komonen, 2012; Volker et al., 2012; Y.C. Wijnia & Herder, 2010). These authors emphasize the increasing strategic importance of asset management at a corporate level and the following factors are a selection of the reasons for this trend: Aging of asset systems; Increased quality, safety and environmental requirements; growing risks; growing competition and turbulence in the market; and an increased pressure for profitability and returns on assets (Komonen, 2012). In this research the more recent definition of asset management is adopted.

1.2 Asset Management Systems (AMS)

Because of these reasons mentioned above, the asset management community has been searching for best practices and ways to integrate asset management in the organization. Both in Australia and New Zealand and in the United Kingdom this has received a lot of attention and the asset management communities in these countries have produced the first international standards, in which the systematic integration of asset management in an organization has been written down: The International Infrastructure Management Manual, written by the New Zealand Asset Management Support Group (first edition published in 2000) and the Publicly Available Specification (PAS55) on Asset Management, written by the Institute of Asset Management (first edition published in 2004) (IAM, 2008; NAMS, 2011). This has been picked up by the International Organization for Standardization (ISO) and very recently the ISO has brought out the first version of the ISO 55000 series, providing an overview of asset management and asset management systems and the specific requirements for an asset management system. The definitions of and relations between asset management, an asset management system and the assets are visualized in the figure below.



1: Asset management in the organization, adopted from ISO 55000 (ISO, 2014a, p. 4).

The figure shows that an asset management system takes a place within the concept of asset management. However, asset management does not necessarily require a systematic approach. Some aspects of asset management can be applied in the organization, without implementing a complete system around these aspects. This research however focuses on the application of asset management systems in an organization. The dashed line around the asset management system displays the possibility to get certification for an asset management system by an external certification institute. The line is dashed, because certification is not considered a necessity for a functional asset management system.

1.3 Research Problem

Although the importance of asset management in organization has increased due to the reasons mentioned earlier and the standards for asset management systems claim many significant improvements and benefits, the awareness of the need for an asset management system has not

reached the top levels of organizations. Wijnia and Herder for example found in discussions with 30 asset managers from infrastructures in the Netherlands that these asset managers have difficulties in convincing top management of the strategic value of asset management and aligning the technical asset management standards with the organizational goals (Wijnia & Herder, 2010). The first difficulty is also acknowledged by Schipper and Dik in their business case for the PAS 55. They notice that asset managers are looking for an answer to the question of how to get executive attention for the need for PAS 55. According to them, the reasons is that top management will not commit to the implementation of an asset management system without having a solid business case for it (Schipper & Dik, 2013). These examples make clear that there is a need for research into the impact of asset management on organizations, as this knowledge is necessary to be able to make a informed decision on whether or not to invest in such a management system. This need is acknowledged by Hodkiewicz, who, in a paper on where asset management is headed, identifies that currently all concepts of asset management have been based on anecdotal evidence and claims by consulting organizations and industry associations and that there is a demand for empirical research and multiorganization comparisons on what factors are important in the assessment of the impact of asset management (Hodkiewicz, 2014).

So on the one hand the research problem is formed by the lack of empirical research to support the claims about positive effects off asset management systems on organizations by the norms themselves and consulting organizations. On the other hand, asset management system standards have existed for only a little more than a decade, meaning that empirical and comparable data is of multiple organizations is hardly available. Most asset management experts agree that it takes at least three years after the implementation of an asset management system, before effects on performance are consistent and can be assigned to the new approach (Hodkiewicz, 2014). Thus, this research aims to fill the gap of the lack of empirical data on the impact of asset management systems, by analyzing the experiences of multiple organizations.

1.4 Research Context

To be able to perform multi-organization analysis on the impact of asset management systems, a target group of organizations has to be sought that has already developed asset management capabilities and has implemented an AMS. A lot of scientific literature on asset management focuses on the implications for organizations owning and managing infrastructural assets (Gay & Sinha, 2013; Kostic, 2003; Vanier, 2001; Volker et al., 2012; Way, 2013). Therefore, in the search for a suitable context for this research, the researcher has looked into the maturity of asset management in different sectors with large infrastructures. The operators of electricity and gas grid have been increasing their attention for asset management systems. Especially in the Netherlands, where a sector-specific norm has been developed that was based on the PAS 55, all grid operators have implemented an AMS. For this reason, the research will take place in the sector of electricity and gas grid operators. The context of the research is further narrowed down and explained in Chapter 3.

1.5 Relevance and Originality of Research

This research attempts to fill the knowledge gap on the impact of asset management systems. By combining the existing literature on the impact of management systems, like ISO 9001 and ISO 14001, and experiences in the sector of grid operators, the research aims to identify relevant positive and negative impact factors of implementing an asset management system using empirical methods and analyses. It also attempts to isolate which challenges an organization is likely to face during

implementation and what the critical factors are for a successful implementation. Furthermore, the research should point out what company values are mostly influenced, positively or negatively, by the implementation of the asset management system.

The approach used in this research is broader than approaches of existing literature on impact of management systems. The difference seeds in the definition of impact. The existing literature on impact of *quality management* systems is vast and most of these papers study the effects of a management system on one particular company value, like financial or business performance (Chow-Chua, Goh, & Wan, 2003a; Sharma, 2005). Furthermore the studies often look at one specific aspect of implementing a management system, like the certification process (Summers Raines, 2002; Zaramdini, 2007). This research makes a distinction between impact of the implementation process on the organization *and* impact that results from the asset management system itself. Hereby, the links between the impact factors and all company values are studied, to find out which values are influenced the most by the implementation of an asset management system.

Practically, the insights from this research into the impact of asset management systems can be used to make informed decisions on whether or not to implement such a system and what aspect to take into account for a successful implementation. Reflection on the methodology should give rise to further research on either the methodology itself or the impact of management systems in a different context.

1.6 Research Objectives

The main research objective is: 'To create insight in the impact of implementing an asset management system on organizations'. The main objective can be divided into several sub objectives:

- Define what "impact" means in the context of implementing a management system;
- Establish an overview of possible impact based on management system literature;
- Based on management system literature, develop a methodology to study the impact of an asset management system;
- Identify the most relevant factors of the impact of an asset management system;
- Based on the results, identify relevance for the asset management community;
- Provide specific areas of focus for further research into the impact of asset management systems.

The research should results in two deliverables. Firstly a methodology for determining impact of asset management systems will be developed. Secondly, based on the methodology, the impact of asset management systems will be described mainly in terms of its qualitative aspects.

1.7 Research Questions

Based on the exploration of the concept of asset management and the research problem and the establishment of the research objectives the research questions can be formulated. The main research question is:

"How to create insight in the impact of implementing an asset management system (AMS)?"

The main research question can be divided into the following sub questions:

1. What does impact mean in relation to the implementation of a(n asset) management system?

- 2. What are possible impact factors of management systems, based on existing literature?
- 3. What is, based on existing management system literature, a suitable methodology to assess the impact of asset management systems?
- 4. What are the most important impact factors according to electricity and gas grid operators?
- 5. How can the impact of implementing asset management system be visualized/presented?
- 6. What are the implication of the results for the asset management community?

1.8 Research Approach and Report Outline

Figure 2 is a schematic representation of the research approach. As the literature on the impact of asset management systems is limited and the literature on the impact of other management systems is vast, extensive literature study on the impact of management systems is performed in Chapter 2. The asset management community is said to face a similar situation as quality management in the 1980s (Hodkiewicz, 2014) and therefore literature on the impact of quality management is a useful source for what the possible categories of impact are, for methodologies for determining this impact and possible impact factors of asset management systems. In Chapter 3 some additional context about the sector under study is provided, before the methodology is developed, based on the available literature and the specific context of this research in Chapter 4.

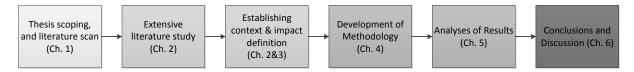


Figure 2: Schematic representation of the research approach.

In this research the definition of 'impact' is a central theme. What impact means in this research and what is exist of, is visualized by the scheme below. The scheme is formed on the basis of the definition of impact from the definition by the Cambridge University Press. Impact is defined as 'a powerful effect that something, especially something new, has on a situation or a person' (Cambridge University Press, n.d.). The 'powerful effect' in this definition is the topic of this research, 'something new' the asset management system and 'a situation or person' is the status quo of the organization at which the AMS is implemented. The categories of impact that are considered result from the literature study on impact of other management systems in Chapter 2. The different aspects of the organizations under study that are influenced by the implementation of the AMS are determined in Chapter 3.

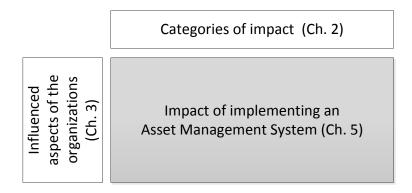


Figure 3: Scheme of how impact of implementing an AMS will be visualized throughout this research.

2 Management Systems: A Literature Study

Management systems are frameworks of processes and procedures used to ensure that an organization can fulfill all tasks required to achieve its objectives (Anderson, 2005). Management systems can be applied to many different kinds of management areas, such a quality, knowledge and environment. Most management systems include a Plan-Do-Check-Act cycle. This PDCA cycle was developed by Edwards Deming and is also called the Deming-cycle. It guarantees the continuous focus on improvement and is especially applied in quality management concepts (Senapati, 2004).

2.1 Definition of a management system standard

From 1947 the International Organization for Standardization or ISO has been capturing best management practices. The organization develops and publishes international management standards based on the knowledge of experts and some of their most well-known management system standards are ISO 9000 for quality management and ISO 14000 for environmental management. Besides ISO there are more international and national organizations for the development of management norms and standards. A standard can be defined as "striking a balance between the requirements of users, the technological possibilities and associated costs of producers, and constraints imposed by government for the benefit of society in general" (Tassey, 2000, p. 588). The process of standardization is the pursuit of conformity, with the objective of increasing the efficiency of economic activity. By affecting both innovation and technological diffusion, standardization can have either positive of negative economical effects. Extending a technology's life cycle through standardization could be positive, unless the standard inhibits (investments in) the development of new technologies (Tassey, 2000).

Thus, a management systems standard is a prescribed framework of requirements, based on best practices, to build a management system. These standards are written in a generic way so that any organization, for which the management system might be relevant, should be able to implement it. In general, management system standards prescribe *what* should be implemented and stay merely neutral on *how* it should be implemented. Furthermore, these definitions assume that such a system has some effect on the economic activity of an organization.

2.2 Typical implementation process of a management system

Based on interviews with system experts, certifying institutes and certified organizations a typical implementation process is described below. The implementation process generally starts with the acquisition of the norm. A norm, like ISO 9000, thus prescribes what it takes to build a management system. A project team is normally assigned to guide the implementation process and has the responsibility to see to it that progress is made according to schedule. Also the organization will be subject to a baseline scan to see what is already in place for building the system and where the main deficiencies are. The test is generally executed by a certifying institute or a external consultant and enables an organization to see where they stand on the maturity scale. Such a model indicates the different levels of maturity of internal processes and assist in professionalizing institutional processes (Volker, Lei, & Ligtvoet, 2011). A typical maturity model is shown in the figure below.

After the calibration test, the implementation process starts. Based on the outcomes of the test the focus will be on undeveloped areas of the management system. Improving the system is an ongoing

process and generally there is not a 'certain moment in time' when a system can be said to be operational.

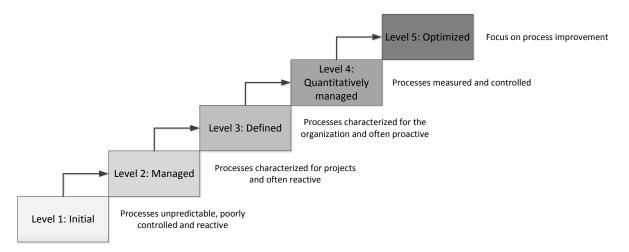


Figure 4: Typical maturity model, adapted from ("Capability Maturity Model Integration," 2010).

At some point the organization might decide to pursue certification for their system by a certifying institute. Getting a certificate requires some additional efforts, but should also take along additional benefits, because the quality of the system is acknowledged by an external auditor. Often a gapanalysis is performed by the certifying institute or an external consultant to point out the remaining shortcomings of the system. During a gap analysis every requirement for the certificate is tested against the existing system and all these aspects are given a grade between 1 and 5 for their maturity. Overall the maturity level of the system needs to be at least between 2.5 and 3 to be certified. Certification happens by means of audits by the certifying institute. Once an organization is certified for its system, audits will be repeated generally every year. After certification, ideally the system is embedded in the organization and continuous improvement is part of daily operation. The project team for implementation is decomposed. The duration of the implementation depends on multiple aspects, for example the starting situation of the organization, the maturity, and the decision whether or not to certify the system. Expert experiences indicate that it takes at least a full year to get a proper system of certifiable quality in place. The typical implementation process is displayed in the figure below. The size of the boxes does not represent the length of the associated element. These boxes represent chronologically logic steps in the process.

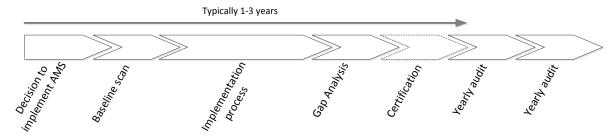


Figure 5 A typical process for the implementation of a management system (Own ill.)

2.2.1 Implementation Process Versus Certification Process

Although the phrases *implementing an ISO standard* and *ISO certification* are used interchangeably, most of the literature on management systems has focused on the impact of *certification* for a

management system. This means that these studies have only taken organizations into account that have received certification for their management system. As was explained earlier, the amount of organization with a certified asset management system is limited. Therefore this research also includes organizations that are currently implementing an AMS of have implemented an AMS but did not yet receive certification for is, as these organizations are expected to be able to report some forms of impact already.

2.3 The content of a management system standard

Most management systems are based on the principle of the Deming cycle or Plan-Do-Check-Act cycle. This means that they require an organization to put the processes and procedures in place to plan activities related to the specific management field, execute them, reflect on them and finally act to improve the execution of the activities in the next cycle. The ISO has recently launched a new, high level structure for their norms, which represents this PCDA-cycle in a visual manner. Using common terminology, core requirements and structure for their management norms, they have attempted to simplify the integration of different management systems (Hortensius, 2012). New management norms and revised old ones are now structured in the same way, as is depicted in the figure below.

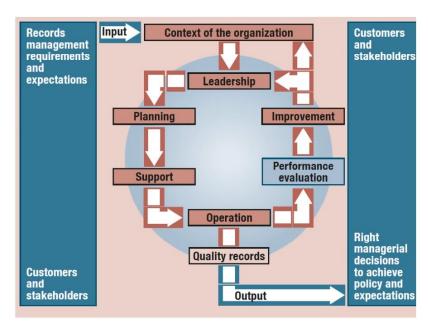


Figure 6: The high-level structure of ISO management norms (Hortensius, 2012).

The cycle is indicated by the arrows and the blocks between them represent the chapter headings, which are now common in all ISO management system standards. Context of the organization, leadership, planning, support, operation, performance evaluation and improvement are the chapter 4-10 of the standard, in which the requirements for every topic are described separately. How these requirements are translated to the actual system differs from one organization to the other.

2.3.1 ISO 55000

In order to give a better idea of what is required for an asset management system, the chapters and content of the recently launched ISO 55000 for asset management will be shortly described below. The ISO 55000 is based on the PAS 55 and thus has many similar requirements, however in the ISO 55000 there is more attention for stakeholder management, financial traceability and leadership. The differences in structure between the PAS 55 and ISO 55000 has been visualized in Annex G.

The ISO 55000 is subdivided in ISO 55000, ISO 55001 and ISO 55002. ISO 55000 provides an overview of asset management and asset management systems (ISO, 2014a). ISO 55001 specifies the requirements for the establishment, implementation, maintenance and improvement of an asset management system (ISO, 2014b). Finally, ISO 55002 provides guidance for the application of ISO 55001 through explanatory text and examples (ISO, 2014c). First of all, the norm requires that the organization determines all external and internal issues, relevant stakeholders and their needs and the criteria for decision making in order to understand the context of the organization. Based on this, the scope of the asset management system is determined (Ch. 4). Then the norm demands from top management that it shows leadership and commitment to the system, establish an appropriate asset management policy and the assignment of relevant roles, responsibilities and authorities (Ch. 5). With regard to planning, the organization is required to determines risks and opportunities for the system, set appropriate objectives and a planning to achieve them (Ch. 6). In terms of support, the organization should ensure sufficient resources are available for implementing the system, appropriate competences and awareness among involved employees and appropriate ways of communication. Furthermore, they should determine the requirements for information and documentation of the information (Ch. 7). The organization will have to establish processes to implement the actions and meet the requirements mentioned earlier and establish tools to control progress (Ch 8.). The organization shall put tools in place to monitor, measure, analyze and evaluate the performance of the system (Ch. 9). Finally, it is required that the organization lays down how to react to non-conformities with corrective or preventive actions and how continual improvement of the system and asset management procedures is achieved (Ch. 10).

The asset management standard also suggests the separation of three different roles: Asset Owner, Asset Manager and Service Provider. The relations between these roles are visualized in the figure below. Generally the asset owner is someone from top management and focuses on the fit of the AMS in the overall strategy of the organization. The asset manager is the head of the asset management department and makes plans to achieve the goals set by the asset owner. A service provider can by either in-house or an external party and executes the plans that are drafted by the asset manager. The reason for this role separation is that it introduces conflicting interests. An asset owner will keep a sharp eye out for the asset manager, as in the end he will have to defend the reports and results towards the shareholders. The asset manager will be more keen on the reports of the service provider, because he will be accountable towards the asset owner.



Figure 7: The suggested role-separation, adapted from the Liander AMS (Liander, 2013).

2.4 Impact of Management Systems: A Literature Review

In this paragraph a review of literature on the impact of management systems is presented. The definition of impact in this research is based on the definition given in the Cambridge University Press dictionary. Impact is defined as 'a powerful effect that something, especially something new, has on a situation or a person' (Cambridge University Press, n.d.). The 'powerful effect' in this definition is the topic of this research, 'something new' the asset management system and 'a situation or person' is the status quo of the organization at which the AMS is implemented.

The situation the asset management community is now in, where there is enthusiasm, but lack of evidence that asset management and asset management systems deliver organizational and financial benefits is similar to the situation of quality management in the 1980s (Hodkiewicz, 2014). Her paper also looks at the literature from the QM sector to identify lessons for asset managers, which illustrates that this literature is a valuable starting point for this research. An overview of the studied literature is provided in Annex B. For every paper in this overview three different components where filtered. First of all, the methodologies used in the papers were filtered to provide input for the methodology in this research. This methodology will be discussed in Chapter 4. Secondly, the different categories of impact factors that are under study in these papers were listed, to provide an overview of what aspects of impact can be studied in management system literature. These categories are discussed below. Finally, the possible impact factors in all these categories were filtered from the impact studies and listed in Annex C. This is elaborately explained in paragraph 2.5.

2.4.1 Different Categories of Impact Factors

This research takes into account five categories of impact elements, identified from literature on the impact of management systems. Literature has been found using several web databases like Google Scholar, Web of Science and Scopus, through the TU Delft network. An initial search using *impact of management systems* as entry resulted in some general papers. After this, some more specific entries using *ISO* yielded more usable results for this research. Most of the existing literature of ISO management systems relates to ISO 9000 for quality management and ISO 14000 for environmental management. So, to find specific results on impact studies and the used methodologies the following search entries were used:

- Positive/negative impact of ISO management systems
- Positive/negative impact of ISO 9000/9001/14000/14001
- Positive/negative results of ISO 9000/9001/14000/14001
- Positive/negative effects of ISO 9000/9001/14000/14001
- Positive/negative value of ISO 9000/9001/14000/14001
- Benefits of ISO 9000/9001/14000/14001

The literature that was found with the search terms above were filtered for relevance. Every paper of which the objective or the results had something to do with impact or effects of the management systems was included, regardless of which sector, geographical area or context the study was placed in. Furthermore, no study was left out because of size or age.

In the figure below, the identified categories of impact elements and their relation to the implementation process are visualized. What should be mentioned here, is that certification does not necessarily needs to be part of the implementation process, which is indicated with the dashed line.

Even though the figure implies that the implementation stage is finished before the first results will surface, the implementation phase can cover a long period of time and may include the expression of short term results and even certification can be part of the implementation process.

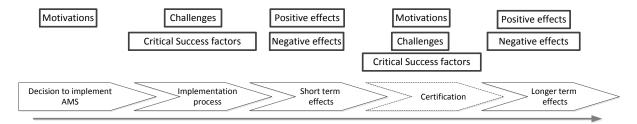


Figure 8. The different categories of impact in relation to typical stages of an implementation process (own ill.).

An organization can have various motivations for deciding to implement an AMS. The category of motivations is taken into consideration, because the literature on the implementation of management systems learns that the type of motivations can significantly influence the results of the management system (Gotzamani & Tsiotras, 2002). Furthermore, it is interesting to study whether or not the implementation has fulfilled the motivation, by comparing the obtained results with the initial expectations. This relation has been de subject of study in the works of Terziovski, Samson, & Dow, 1997; Zaramdini, 2007.

The second category includes the potential challenges, which can appear during both implementation and the certification stage and come in different forms and terms. Withers and Ebrahimpour discuss the obstacles during implementation and time and effort consuming requirements of the ISO standard (1999), while Chow-Chua et al. analyze the effect of the encountered barriers (2003a).

The next two categories are the positive and negative effects of implementing a management system. One would expect that the management system will bring some advantages to the organization, otherwise there would not be a lot of sense in the decision to implement. This assumption is confirmed by most of the studied literature and claimed by the International Organization for Standardization (ISO, n.d.). Related literature however indicates that these systems also come with some negative effects (Douglas, Coleman, & Oddy, 2003; Moatazed-Keani & Ghanbari-Parsa Sechi, 1999). These two categories form for a greater part the actual impact of the implementation of the system.

Finally, the critical factors for successfully implementing an AMS are included in this research. Although they do not contribute to the impact directly, they follow from the experiences of organizations during implementation and from the results of the implementation and they can significantly influence the success of future implementations. Mallak et al. have specifically focused on the relevant cultural values that are critical for a successful implementation and values that hinder a successful process (1998), whereas Carlsson and Carlsson have used a more broad approach and discussed all reported factors for successful implementation (1996).

2.4.2 Definition of Impact Resulting from Literature Study

So far the literature on impact of management systems has helped to further narrow down the definition of impact in this research. Based upon the definition of impact from the Cambridge University Press dictionary, two elements of the definition have now been described. 'Something

new' is the AMS itself and the 'powerful effect' exists of the motivations for, challenges of, positive and negative effects of and the critical success factors for implementing an AMS. In the next chapter the focus is on what aspects are to be influenced by the AMS.

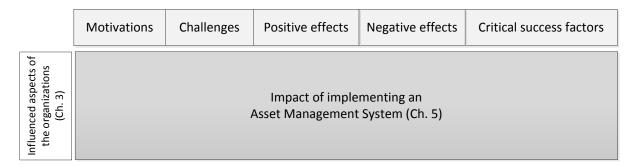


Figure 9: The different categories of impact as the first step in the visualization of impact of implementing an AMS.

2.5 Possible Impact Factors Resulting from Literature Study

As has been explained earlier, not much literature on the impact of asset management systems exists. Therefore the literature on impact of other management systems is used to identify potential impact factors of implementing an AMS. Furthermore, management system standards from the ISO are written in a similar structure, with the same chapters and comparable requirements (Hortensius, 2012). This indicates that some aspects of impact of implementing an AMS, like the changes in an organization, might be comparable to the introduction of other management systems. Management system have, among others, the purpose to systemize or structure management procedures, whether this is in terms of quality, risk or asset management. This also suggests that these systems could create similar effects and therefore, results from management system studies are taken as a starting point for possible impact of an asset management system. Lists of impact factors are filtered from literature and placed in one of the five identified categories.

This is complemented with the impact that is claimed by the different norms on asset management, like the ISO 55000 and PAS 55. These norms all provide lists of intended benefits of implementing an asset management system. The results of the literature research are presented in Annex C and provide the basis for a question framework.

From the sources of information mentioned above, lists of motivations, challenges, positive and negative effects and critical success factors are drafted. Together this provides an initial version of a question framework. As many of the identified elements, especially challenges, negative effects and critical success factors are extracted from literature on other management systems, the content of this framework is tested on reasonability for asset management purposes by asset management experts. Obviously, some of the aspects that surface from the literature review are not relevant for implementing an asset management system. In elaborate discussion with assessors of asset management systems, the content of the framework is critically reviewed, by asking questions like: "If I would be an asset manager of a transmission or distribution system operator, could this reasonably be an element of motivation to implement an asset management system?" For most of the elements the assessors recognized its relevance by experience in assessing asset management systems or indicated that they could imagine that the element could be of impact. The testing of the questionnaire by subject-experts has been part of the methodology in other studies as well (Withers & Ebrahimpour, 1999).

2.5.1 Sub-categorization of Impact Elements

After the review, the long lists of impact-elements are organized into factor-trees, in which the factors are sub-categorized. This has been organized as follows:

- All factors found in literature are firstly defined as a possible motivation, challenge, positive
 effect, negative effect or critical success factor, based on the way they were described in the
 regarded literature;
- Within these categories another categorization is made based on the most prevailing categorization in the regarded literature and all factors are gathered under one of the identified categories. If a factor is encountered, which cannot logically be placed under one of the categories, this factor is evaluated for its relevance. If it is found relevant, another category is added to the list;
- Factors which appear twice of more times on the list are brought back to one. Obviously, the
 same factors are not described exactly the same in different studies, so based on reasoning it
 is determined whether they are the same or not. Furthermore, some factors are a more
 concrete version of a more abstract factor. In that case the more abstract factor is kept in the
 list and the detailed version is added to notes, so that it can still be asked during interviews;
- With the help of asset management experts, the list is further narrowed down based on the relevance of the identified factors for asset management system implementation.
 Furthermore, the factors are brought to the most abstract factors that are found. The reason for this is twofold:
 - 1. The framework will be used in interviews and during the interviews the strategy is to start with abstract factors and then based on the response of the interviewee go into more detail. This way it is possible to identify a concrete factor that has been relevant for an organization, by discussing the abstract theme with the interviewee in more detail. If the interviewee is asked if a very detailed factor has been of influence to their organization, he might not recognize it and so not everything is covered.
 - 2. After the round of interviews, the question framework will be revised and used for an online survey. In a survey a reasonable amount of questions should be presented. If there are too many questions, this will influence the number of responses negatively. The categorization of the factors on an abstract level results in a manageable amount of questions for the survey.

To visualize this process, the figure below show the relation of impact, the five different categories of impact, the sub-categories and the abstract factors. In principle, all aspects that are found in literature and pass the content check are taken up into the question framework. However, it depends on the level of abstraction of the element whether it is taken up as a single question in the framework or as note to a question. Furthermore, elements of the same level of abstraction have the same weight in the framework, regardless of how many times the one element is found in literature compared to the other.

What should be kept in mind at this stage, is that the elements that are identified in literature and categorized in factor trees, like in Figure 10, are only elements of possible impact of the implementation of an asset management system. It is part of the methodology, that as the research

Master of Science Thesis

proceeds impact is more specifically defined in terms of these elements. So the categorization of impact elements is an iterative process. The resulting factor trees are displayed in below.

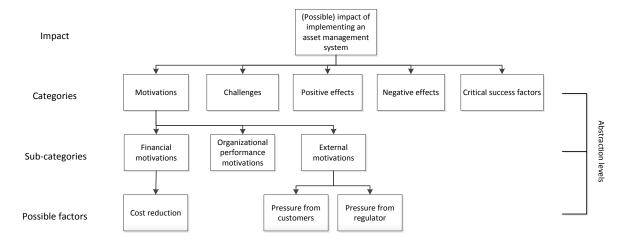


Figure 10: Schematic overview of the categorization of impact in five categories and the sub-categorization of motivation as an example of the categorization process.

Many possible impact factors have been extracted from articles on the impact of mainly ISO management systems and subdivided into the five different categories of impact. Based on this main product of the literature research, which is presented in Annex C, the following factor trees are formed, for possible motivations, challenges, positive and negative effects and critical success factors. These trees are displayed on the following pages.

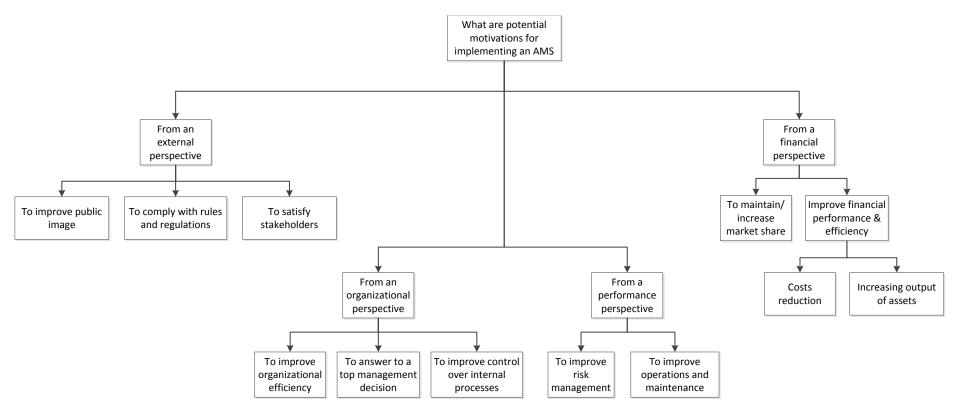


Figure 11: Factor tree of possible motivations for implementing an AMS, resulting from the literature research.

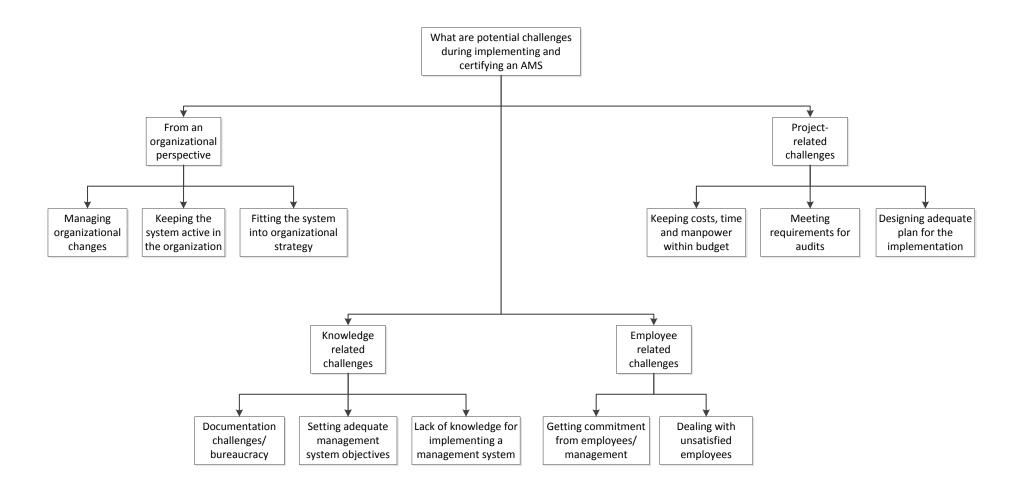


Figure 12 Factor tree of possible challenges of implementing an AMS, resulting from the literature research.

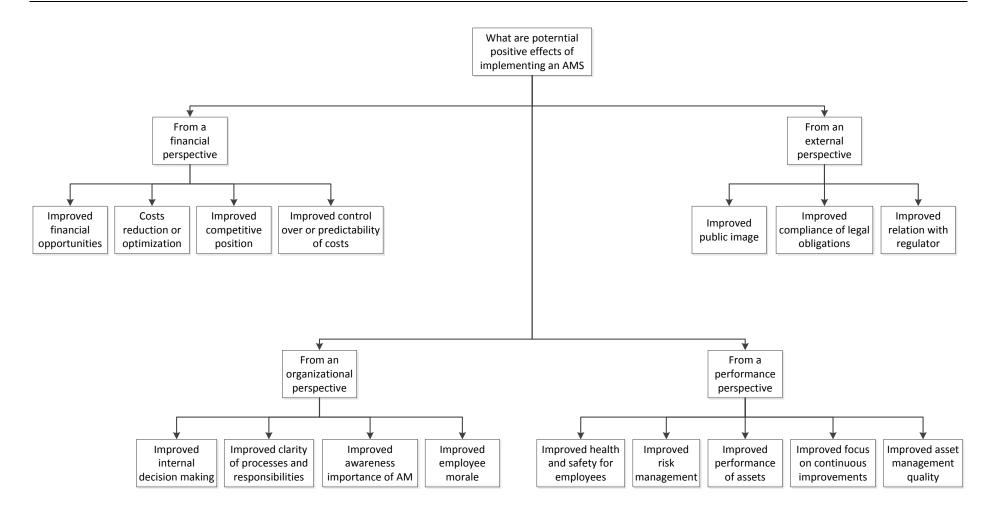


Figure 13: Factor tree of possible positive effects of implementing an AMS, resulting from the literature research.

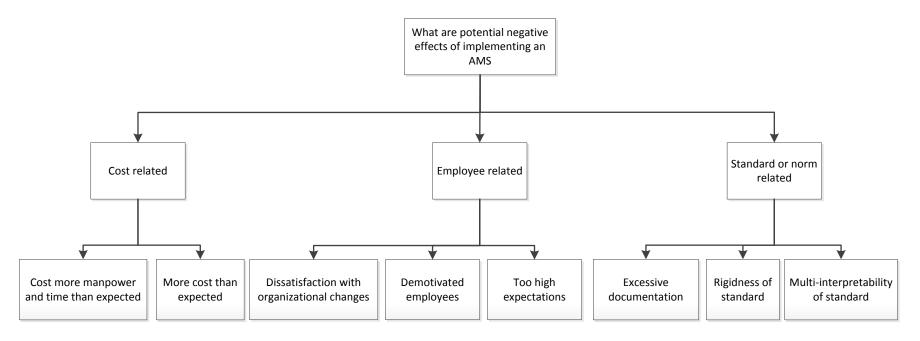


Figure 14: Factor tree of possible negative effects of implementing an AMS, resulting from the literature research.

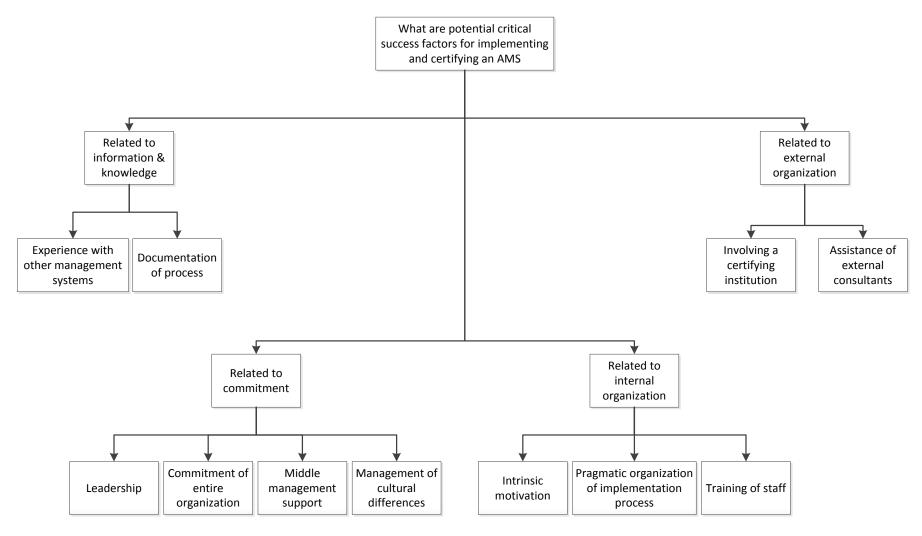


Figure 15: Factor tree of possible critical success factors of implementing an AMS, resulting from the literature research.

3 A Sector Study: Power & Gas Grid Operators

3.1 Choice for a Sector-Specific Study

As has been mentioned in the introduction, the asset management community is in need for empirical research on the impact of asset management systems using multi-organization comparisons (Hodkiewicz, 2014). Therefore, participating organizations in this research are required to be of a comparable nature. Furthermore, these organizations will have to be able to show results of and share experiences about the implementation of an asset management system. There are multiple characteristics based upon which organizations may be comparable. In the management system literature, many papers study the impact on organization within a certain geographical area (Chow-Chua et al., 2003a; Gavronski, Ferrer, & Paiva, 2008; Schylander & Martinuzzi, 2007; Zaramdini, 2007). Other studies focus for example on the impact in a specific sector (Carlsson & Carlsson, 1996; Moatazed-Keani & Ghanbari-Parsa Sechi, 1999).

In this research, both these characteristics apply to the target group of organizations: Dutch operators of electricity and gas grids. These grid operators have comparable assets, organizational structure, corporate values and stakeholders. They are publicly owned organizations and operate in the same regulatory landscape, which means that they have to comply with the same rules and regulation. Furthermore, in the Netherlands a sector-specific norm has been written for the management of electricity and gas grids, based on the PAS 55 and all grid operators in the Netherlands are currently implementing of have already implemented an AMS. Finally because the sector is regulated, a lot of information on both their financial and asset performance is publicly available. This makes this group of organization very suitable for this research. Before the methodology for the research is presented, some additional context on this target group of organizations is provided.

3.2 Power and Gas Grid Operators in the Netherlands

In the Netherlands, production of power and gas and the management of the transportation networks are segregated since the end of the 1990's. The network-operating part became regulated after European agreements about the liberalization of power production (Rijksoverheid, 1998). Production companies that owned and maintained (part of) a network had to completely separate that part of the company from the production part, so that production companies without a network to transport their power had equal chances and paid similar prices to network operators for the transport of power.

3.2.1 Increasing Pressure on Grid Operators

The separated parts of the energy companies, the grid operators, are under the supervision of the regulator Autoriteit Consument en Markt or ACM. The ACM demands from these operators that they offer high reliability of delivery, high quality products and low grid tariffs (ACM, 2013). Furthermore, because of their public function they require transparency of decision making and operation, which translates to publicly available annual reports and a 'Quality and Capacity' document, which has to be published by the operators once every two years. In these documents they have to present their short-, medium- and long-term plans for their networks to ensure reliability and performance.

Energy infrastructures are under increasing pressure from different angles (Wijnia & Herder, 2010). First of all some (parts of) infrastructures are starting to show signs of their ending lifetime, like the

gas infrastructure (Wijnia, Korn, Jager, & Herder, 2006). This network has been build in the sixties and is now starting to show a decline in performance and it is expected that larger parts of the infrastructure will have to be replaced in the coming decades. Besides the declining state, the increasing uncertainty about the role of natural gas in the future of energy provision poses another problem. Questions are raised about the ability of the network to cope with new requirements, like the entry of biogas into the gas system. The production side of energy is changing rapidly. Many new forms of energy find their way to consumers and consumers generate their own electricity, which they would like to feed back into the grids when it is economically favorable. This requires from the grid operators that they are flexible and adapt to these trends (Netbeheer Nederland, 2011).

3.2.2 Early Adopters of Asset Management Systems

All these developments have led to an understanding among the electricity and gas grid operators that an asset management system can assist these organizations to comply with all these demands. Early adopters in the Dutch sector have copied asset management related procedures from companies in the British utilities sector. Enexis, one of the Dutch electricity and gas distribution system operators, was the first organization in the Netherlands to receive a PAS 55 certificate for their asset management system in 2005 and other followed in the years after. Below an overview is provided of the Dutch transmission and distribution system operators, their operating areas and the certificates they have received for their asset management systems.

Table 1: Overview of Dutch transmission and distribution system operators of gas and electricity.

Organization name	Type of company	Region & size	Asset Management System
GTS	Gas TSO	National	-
TenneT	Electricity TSO	National	NTA 8120/ PAS 55
Enexis	Electricity & Gas DSO	Limburg, Noord-Brabant, Groningen, Friesland & Drenthe, ±4.5m clients	NTA 8120/ PAS 55
Stedin	Electricity & Gas DSO	Zuid-Holland, Utrecht, ±3.8m clients	NTA 8120/ PAS 55
Liander	Electricity & Gas DSO	Noord-Holland, Zuid-Holland, Gelderland, Flevoland, ±5.1m clients	NTA 8120/ PAS 55
Endinet	Gas DSO	Eindhoven, Helmond and surrounding municipalities, ±500k clients	NTA 8120
Rendo	Electricity & Gas DSO	Drenthe & Overijssel, ±130k clients	NTA 8120
Cogas	Electricity & Gas DSO	Overijssel, ±190k clients	NTA 8120
Westland Infra	Electricity & Gas DSO	Westland, ±100k clients	(?)
Delta	Electricity & Gas DSO	Zeeland, ±400k clients	NTA 8120

As assets in different industries and sectors have different requirements, even standards do not always apply generically, or at least need some additional guidelines to fit certain sectors or even individual companies. An example of such an additional document is the Nederlandse Technische Afspraak 8120 (NTA 8120), which has been composed by all Dutch grid operators together with another regulator Staatstoezicht op de Mijnen (SodM). This document is aimed at formulating the specifications for the optimal management of the safety, quality and capacity of the Dutch electricity

and gas networks and it is based on the standard PAS 55 (NEN, 2009). Although it is based on the PAS 55, it goes more into detail on the specific context of the sector and compliance with the NTA8120 usually means that PAS 55 is also complied with.

3.3 Impact of an AMS at Dutch Grid Operators

From the Cambridge University Press dictionary definition of impact ('a powerful effect that something, especially something new, has on a situation or a person'), 'something new' was already defined as the asset management system and 'a powerful effect' exists of the five different categories of impact factors. Therefore the only remaining term is 'on a situation or person'. Most of the studied literature on the impact of management systems does not specifically define this 'situation', but merely focuses on general terms, like the influence on performance or business performance (Chow-Chua et al., 2003a; Sun, 2000). This research aims to structure the different aspects of the organizations under study, which are influenced by the implementation of an AMS. The impact of an AMS is therefore based on the influence of implementing the AMS on the company values of these grid operators. These company values represent what is important to these organization and this is illustrated by a quote from the Liander Quality and Capacity document: 'The Asset Owner determines the company values in relation to the strategic goals of the organization and balances these values relative to each other in decision making' (Liander, 2013). The following table provides an overview of the company values of some of the Dutch grid operators.

Table 2: Overview of important stakeholders and corporate values of some of the Dutch grid operators.

Operator	Source	Company values
TenneT	(TenneT, 2013)	Quality (safety, efficiency), integrity.
Enexis	(Enexis, 2014)	Affordability, reliability, legality, safety and sustainability.
Liander	(Liander, 2013)	Safety, reliability, affordability, image, finance, sustainability, compliance.
Stedin	(Stedin, 2012)	Safety, quality, financial efficiency.
GTS	(GTS, 2013)	Safety, reliability, environment, reputation, financial performance.
Endinet	(Endinet, 2014)	Safety, reliability, compliance, finance, image, quality of organization.
Delta NWG	(Delta, 2014)	Safety, quality, economy, image, stakeholder relation, sustainability.

As was mentioned before the organizations in this sector are relatively comparable, which is supported by this overview of company values. Based on this overview and conversations with asset managers a general set of company values, applicable to all Dutch grid operators is composed: Reliability, safety, regulatory compliance and the public image. Reliability is an aspect of the performance of the assets and the service that is provided by the operators, which is the transport and distribution of electricity and/or gas. Safety is another aspect of the performance of the assets and is determined by the number of incidents related to the network and the service provided, both with customers and with employees. These organizations operate in a monopoly and are therefore regulated. Being compliant with the rules and regulations is therefore a crucial aspect of the grid operators. They also consider their **public image** as being an important value. This is described as the reputation as a result of media attention, conflicts with regulators, sustainability, etc. The first two values can be measured by statistical data. The degree to which a grid operator is compliance is to be determined by the regulator and the public image is also a more soft value and difficult to measure. Other aspects at these organizations to be influenced are employee satisfaction, organizational effectiveness and financial efficiency. The aspects are not assumed to be company values, but rather preconditions for the existence of almost any company. Obviously, these organizations are

concerned with the satisfaction of employees and consider this important in their decision making. Organizational effectiveness captures not only organizational performance, but internal outcomes of efficient and effective operations and external measures like reputation as well (Richard et al., 2008). Finally, as tariffs for the transport of electricity and gas are determined by the regulator and the assets are capital intensive, financial efficiency plays an important role for the grid operators as well. These values and preconditions have been verified by the interviewees at the Dutch grid operators as relevant to the organization.

3.4 Definition of Impact Based on the Context

The next figure brings together the three parts of the definition of impact. On the left side the possible areas of influence are presented. Above the actual impact are the different categories of impact as explained in the previous chapter. To visualize the impact, the square has to be filled in. If for example a certain challenge influences the reliability, a colored circle is placed on the crossing of challenges and reliability. This methodology is similar to how grid operators rate risks in a risk matrix. An example of such a matrix is provided in Annex A.

This research thus assumes that insight on the impact of implementing an AMS is created by determining the influence of the factors in the five different categories of impact on the values and preconditions for existence of an organization.

This definition is visualized by the figure below. In this research factors of impact in the five different categories are determined and placed into the grey area. Within the area the factors are horizontally linked to the company values and preconditions, which are influenced by the factors.

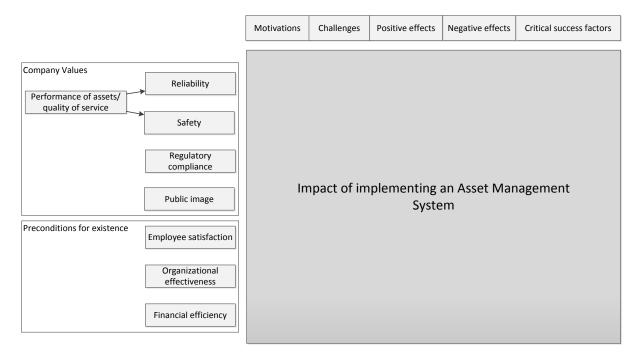


Figure 16: Second step in visualization of what is meant with the term 'Impact' in this research.

4 Research Methodology for Determining Impact

The third product resulting from the literature study, besides the identification of impact-categories and the potential impact factors, is the methodology. From the table in Annex B, displaying the studied literature, it appears that most studies have used a literature review on the relevant management system as input. Furthermore, all studies in the table have used in-depth site interviews, a survey-questionnaire or a combination of both. This research uses a combination of indepth interviews and a survey to create the insight into the impact of an asset management system. As this research is one of the first empirical studies on the impact of asset management systems, there is no established view on what this impact is. To increase their validity, the insights created through this research are therefore formed through data triangulation, (Baarda, De Goede, & Teunissen, 1997). This is visualized in the following figure.

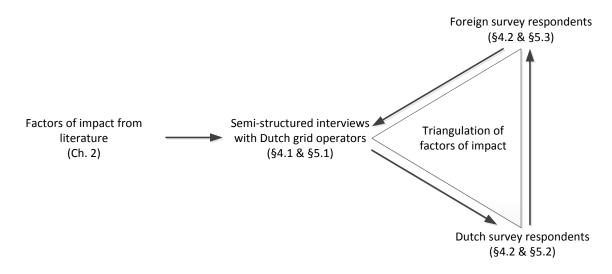


Figure 17: Visualization of triangulation of impact factors through interviews and a survey.

The impact factors identified from literature are used as input for the methodology. Semi-structured interviews are used to form an initial view on impact of implementing an AMS. This view is validated, firstly by the results from respondents from Dutch grid operators and secondly by the results from respondents from foreign grid operators. The choices for and purpose of the separate data-gathering tools are explained in this chapter.

4.1 Semi-structured Interviews with Dutch Grid Operators

4.1.1 Interview Methodology

Most of the discussed papers have used a large survey to gather data for determining impact of management systems. The number of respondents range from about 72 respondents (Schylander & Martinuzzi, 2007) to as many as 4000 respondents (Terziovski et al., 1997). Most other papers use expert-interviews as the main source of information. The objectives of these papers and the reasons for choosing interviews are similar to the those of this research. Withers and Ebrahimpour report ISO 9000 impact and they argue that this is best done by using a case approach and obtain detailed information about the registration process and experiences by conducting in-depth interviews (1999). Another example is given by (Moatazed-Keani & Ghanbari-Parsa Sechi, 1999), who wanted to provide the experiences and perceptions of ISO 9000 from the viewpoint of quality assurance

managers. They deemed this qualitative approach more suitable for gaining detailed information than a large survey.

Because of the lack of empirical research on the impact of implementing an AMS and the limited knowledge of the researcher on the subject, in-depth, semi-structured interviews are used to obtain more detailed information and develop a first view of the impact of implementing an AMS. For every of the five categories of impact interviewees are asked to provide a top three list of factors, based on the relevance for their organization. For example, when the category of motivations for implementing an asset management system is addressed, the open question is asked: "What has been the initial motivation of your organization to implement an asset management system?" This forces the interviewees to focus their thoughts. Furthermore, it is in line with guidelines on how to apply semi- or unstructured interviews (Baarda et al., 1997).

After the open questions the interviewees are asked to verify whether or not the elements identified from literature are relevant aspects of impact of implementing an asset management system for their organization. All the elements of motivations, challenges, positive and negative results and CSF's are checked with the interviewees. Once such an element is acknowledged, the interviewee is asked to provide more in-depth information on the element. Interviewees are asked to visualize the impact at their organization by giving examples. The interview question list, which is composed from the factor trees, is provided in Annex D. Finally, at the end of the interviews the interviewees are asked if they think the list of questions is complete and covers all elements of impact of implementing an asset management system. Based on their responses the line of questioning was adapted for the survey.

4.1.2 Approaching the Interviewees

The sector of electricity and gas system operators is a suitable sector for this research, as they are relatively mature in practicing asset management and asset management is a trending topic among these organizations (Wijnia et al., 2006). Early adaptors like Enexis, a Dutch distribution system operator, have been practicing systematic asset management from the early 2000s and were among the first organizations to get certified with the PAS 55 (Essent Netwerk B.V., 2007). In the Netherlands there are 8 distribution system operators and 2 transmission system operators, one for the gas network and for the electricity network. These organizations and their asset management system certifications are displayed in Table 1. All the organizations where contacted via their websites or through networking sites, like LinkedIn. In the message the organizations were asked if their asset manager of the person responsible for the implementation of the asset management system would want to participate in a two hour interview on the impact of their asset management system. Most of the system operators responded positively. Only from Westland Infra, Cogas and Rendo no response was received. This meant that seven out of ten system operators agreed to be interviewed. Below an overview of the companies and the function titles of the interviewees is provided.

Table 3. Overview of interviewees.

Organization	Function title interviewee
TenneT	Risk Manager
Liander	Manager Risk and Quality Management & Compliance
GTS	Controller Operations & Safety / Property Manager

Delta	Asset Manager
Stedin	Manager Grid Coordination
Endinet	Quality Manager
Enexis	Senior Manager Asset Management & Operations

These organizations are public and their information on performance is publicly available in so-called Quality and Capacity documents, which have to be published every other year. Therefore, it is expected that the asset managers are inclined to be open and honest about the impact of implementing their asset management system. However, these persons are also the promoters of the asset management system in the organization. They will have to convince top management and the rest of the workforce of the effects of the system and they might therefore be somewhat biased about the impact. To include some different perspectives, other involved organizations where contacted as well. The regulating authorities ACM (Authority Consumer and Market) and the SodM (state supervision of mines) where asked to give their view on the impact of implementing asset management systems at grid operators. Furthermore the certifying institute Lloyd's register was approached for their view on the subject as well.

4.1.3 Interview Results

The results from the interviews are used to determine which are the most important impact-factors in the different categories. The factors are ranked on relevance, based on the number of interviewees that signify as having impacted their organization. Furthermore, as the interviewees provide in-depth information on the different factors, it is possible to link them to the company values in the visualization scheme and determine whether they have a positive of negative impact. This is done for every interview individually and presented in Annex H. A combined view of all interviews is presented in §5.5. This visualizes what the most important impact factors are and what values and preconditions of the organization are mostly impacted.

4.2 A Survey Among Dutch and Foreign Grid Operators

4.2.1 Survey Methodology

In addition to and partly based on the in-depth site interviews, a survey is developed posing similar questions to respondent as the interview-questionnaire. The survey is send out to both Dutch and foreign grid operators. Results from Dutch respondent are compared to the insights from the interviews. This validates the created insights on the impact of the AMS, as it is based on the perception of more experts. Furthermore, the outcomes provide insight in how consistently the impact is perceived in the Netherlands.

The purpose of sending the survey to foreign grid operator is twofold. Firstly, additional results from similar companies can add even more weight to the gained insights from the interviews and surveys in the Netherlands. Secondly, these foreign organizations probably find themselves in a somewhat different context than the Netherlands. They might be more or less mature in asset management, or they operate in a different regulatory environment. By taking the context into account, the results will say something about the generalizability of the research. In other words, if an element seems very relevant at all the organizations in the Netherlands, the results from foreign respondents might provide additional information on whether or not that element is very relevant for impact of implementing asset management in general, in this sector only, or in this sector in the Netherlands only. Using a combination of interviews and surveys is quite common in the studied literature

Master of Science Thesis

(Boulter & Bendell, 2002; Carlsson & Carlsson, 1996; Chow-Chua et al., 2003a; Withers & Ebrahimpour, 1999).

Besides rating the relevance of impact factors, respondents are also asked to fill in some static data, like their function title, start date of implementation, date of certification and experiences with other management systems, enabling the researcher to perform additional analyses on the results.

4.2.2 Developing the Survey

For the development of the survey an online platform is used, which is called *formsite*. The choice for this platform is based upon experiences of another graduation student. In the survey a 4-point Likert scale is used because of the following reasons:

- The respondents are assumed to be able to determine how relevant a factor is for the organization, but only on an ordinal scale, because of the softness of most of the factors. Therefore, no numerical scale is applied, but a Likert-scale.
- If the factor is deemed relevant, respondent can indicate whether it is perceived as only slightly relevant, relevant or very relevant to his or her organization. There is no 'neutral' option. Therefore a even number of options is used;
- Based on the limited experience with the impact of the AMS, it is assumed that more than 4 options would ask for too much detail.

There are 5 categories of questions (motivations, challenges, positive and negative effects and critical success factors) and the number of survey-questions per category depends on the numbers of relevant factors that have been identified from the literature study, whether these factors passed the experts test and finally whether they were recognized by the interviewees as possible impact. The content and understandability of the survey, attached in Annex C, have been checked through several measures:

- After adaption of the survey based on the findings from comparing the factor trees with the
 interview results, the content of the survey has been checked for relevance of the factors by
 asset management experts;
- The survey Is sent to a test group of five persons, who are familiar with 'asset management language'. The feedback produced in this group ensures the understandability of the questions;
- The questions are tested on the interpretability by a survey expert. This is another measure to ensure that questions are interpreted by respondents in the intended manner;
- Within the survey, additional explanation of what is meant with the question is added to most of the questions to ensure mono-interpretability of the question;
- A control-question has been added to each category of questions, to enable respondents to add any comments or additional factors.

4.2.3 Approaching the Respondents

All of the interviewees are asked to spread the survey among their colleagues in the asset management department. The respondents are required to have participated in the implementation process of the AMS, to be able to assess the relevance of the factors in the survey. Furthermore, preferably the respondents should have a managerial function in the asset management department,

to ensure a similar organizational perspective in answering the questions. This way the survey results can be compared to the results from the interviews.

Many different pathways were used to reach foreign grid operators. First of all, all interviewees were asked if they have international contacts and most of the larger system operators do have these contacts and agreed to help reaching them. Through LinkedIn the link to the survey was placed on several asset management platforms and asset management experts were contacted through LinkedIn. David McKeown, CEO of the Institute of Asset Management based in the UK agreed to send the survey to some of his contacts. The UMS Group, an international utility management consulting group, send the survey to some of their relevant connections. Some other institutes, like the European Transmission System Operators for electricity and gas (ENTSO-E and ENTSO-G), were also addressed.

4.2.4 Survey Results

Because there is no numerical scale between the answers, the impact factors are ranked within their categories based on the following heuristics:

- The factors are ranked from highest relevance to lowest relevance;
- The first heuristic is the median the impact-factor with the highest median is also ranked highest;
- Factors rated with the same median, are distinguished based on the number of respondents that have rated the factor is at least relevant the factor that has been rated as at least relevant by the highest number of respondent is also ranked highest;
- Factors rated by the same amount of respondents as at least relevant are distinguished based on the number of respondents that have rated the factor as very relevant – the factor that has been rated as very relevant by the highest number of respondent is also ranked highest.

To analyze and compare survey results from different groups of respondents, for example the Dutch and foreign grid operators, the differences of these groups will be tested for significance, be means of a statistical analysis.

4.3 Validation of Results

To reduce the possible bias in the results from interviews and the survey, some additional analyses are carried out. A representative of one of the regulators in the sector, the state supervisor of the mines or SodM, is interviewed to provide its view on the impact of asset management systems. Similar questions as in the interviews with the grid operators are posed and the impact according the regulator is caught in the same figure as the other interviews. Another point of view is provided by a representative of a renown certifying institute, who has been involved with certification processes of multiple grid operators. Furthermore, the publicly available statistical data is analyzed. Once every two years the Dutch operators have to deliver a quality and capacity document to the other Dutch regulator, ACM, in which they present among others their performance indicators, the target values for these indicators and the achieved performance. These documents thus provide objective insights in the performance of the assets of the grid operators. The results of these analyses are discussed in 5.6.3.

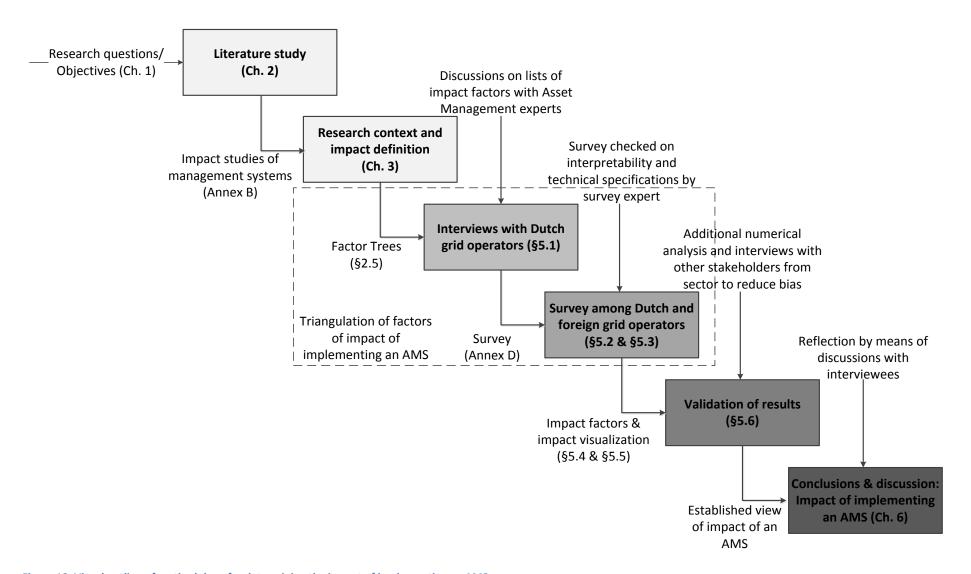


Figure 18: Visual outline of methodology for determining the impact of implementing an AMS.

5 Impact of Implementing an AMS

The results in this chapter are presented in a different order than the chronological order of the used methodological tools. The factor trees provide potential factors of impact of implementing an asset management system, which will be compared to the answers from asset managers of electricity and gas grid operators. These interviewees were asked to lists the most relevant motivations for, challenges of, positive and negative effects of, and critical success factors for the implementation of an AMS, based on their own experiences. These were open questions, so no potential factors were posed in first instance. The comparison of these results are presented in §5.1.

The results of the survey are then presented in §5.2, producing rankings of most relevant factors in all five categories. First the results of the Dutch respondents are discussed, followed by a comparison of the Dutch and foreign respondents in §5.3.

Triangulation of the most important impact factors is then executed, by comparing the survey results to the lists of most relevant factors according to the interviewees in §5.4. Subsequently the factors are linked to the different company values and preconditions for existence of grid operators, based on the in-depth information of the interviewees and the researcher's interpretation, to create a combined insight into the impact of asset management systems in §5.5.

Finally, the results on impact of implementing asset management systems are validated by incorporating the views of other stakeholders in the sector and statistical data in §5.6.

5.1 Comparison of Impact Factors Resulting Interviews and Literature

The in-depth site interviews are executed as discussed earlier with someone within the organization responsible for or at least closely involved with the implementation process of the asset management system. The findings from these interviews are initially processed as notes into the interview format as can be seen in Annex D. In the tables below all relevant factors that surfaced from the open questions during the interviews are bundled and ranked according to the number of times they have been mentioned. Furthermore, they are compared to the potential impact factors, that were identified from the literature and form the lowest levels in the factor trees.

Motivations for implementing an AMS:

- With regard to the motivations, it appears that in almost all cases there is some sort of external pressure. The regulator has increased requirements for grid operators since the law to unbundle in 2004, but pressure was also exercised by shareholders and the empowering public. Their call for more transparency and sustainability has clearly influenced the decision of grid operators to implement an AMS.
- The grid operators all have an intrinsic motivation to develop their organization and this is expressed in different forms. Three of the interviewees indicated that their organization wants to improve the performance of the assets in terms of the safety and security of supply. Some say they want to 'professionalize asset management procedures' or 'professionalize the organization', which is obviously a broad statement. This motivation might include any of the other intrinsic motivations mentioned: Improve the organizational structure, clarify roles and responsibilities and increase internal transparency, especially with regard to (financial) decision making. Internal

transparency also enables more external transparency towards shareholders, the public and the regulator.

- None of the interviewees has explicitly mentioned that their organization was motivated by potential cost reductions, improved financial position or business opportunities, although these are common motivations for implementing other management systems. An obvious reason for this, is the fact that the sector is regulated and the tariffs paid by customers for the use of the grids are set by the regulator and therefore there is no primary focus on costs;
- Besides the motivations to reduce costs or improve the financial position, all other motivations found through the literature study can be linked to the motivations mentioned during the interviews, as can be seen in the table below. Most of these links are not completely one to one, but they are at least associated. An example of this, is the fact that two interviewees mentioned that they were motivated because other grid operators had already implemented an AMS. This does not indicate that the AMS provides a competitive advantage, but at least the grid operators do not want to lag behind the other grid operators. The only motivations that were mentioned by interviewees but not taken up in the factor tree, are the urge for transparency and the situation the organization is in at time of the implementation.

Table 4: Comparison of motivations identified from literature and expressed by interviewees.

Motivations according to interviewees	Motivation from literature				
Motivated by some form of pressure from regulator	To improve regulatory compliance				
Motivated by the urge to increase performance of assets in terms of safety and security	To increase asset output				
Motivated by the urge to professionalize asset management and organization	To improve operations and maintenance/ r management				
Motivated by the urge to be more transparent	2 -				
Motivated by the urge to have clearer processes, roles & responsibilities	2 To Improve control over inte processes/organizational efficiency				
Motivated by other grid operators	To improve competitive position	on			
Motivated by the pressure from shareholders	To Satisfy shareholders				
Motivated by the increasing public pressure for transparency	To improve the public image				
Motivated by pressure from top management decision	To answer to a top-dow decision	n management			
Motivated by the situation the organization is in at the moment of implementation	_				

Challenges of implementing in AMS:

- Most of the interviewed organization have experienced serious challenges in realizing the necessary cultural changes that accompanied the implementation of the system. In most cases this goes hand in hand with the lack of commitment for the system from employees. The workforce had to be convinced of new procedures and it is not surprising that this has caused some problems, as most grid operators have indicated that especially the employees working for the service provider are relatively aged and have worked according the previous procedures for a long time.

- Another real challenge for the grid operators lies in the requirement from both the AMS and the regulator to get the information on their current asset base in order. This means that for all assets they own, they are required to document what it is, what it does, where it is located and eventually what the state is and what it is worth. However, the current grid operators have evolved out of many smaller organizations and during these mergers and digitalization a lot of these data has been lost, which explains the challenge. Some of the larger grid operators indicate that they spend 4-6 million a year to improve data quality.

- Another category of challenges relates to the AMS norms PAS 55 and/or NTA 8120. Grid operators experienced difficulties with the interpretation, the lack of guidance and/or satisfying the requirements. Most of them indicated that they have made use of external consultants to assist in this process.
- Most of the challenges mentioned are related to the integration of the system into the organization, both socially and technically. The social integration is a common challenge for implementing management systems, as can be seen in the factor tree for challenges, and exists of the lack of commitment and realizing the cultural changes in the organization. The challenge of technical integration is formed by difficulties to set clear objectives for the system, especially on the long term. The interviewees assign this difficulty to the need to balance many company values. A quote of one of the grid operators: "Asset management is management of a grey area";
- Most challenges from the factor tree are recognized by the interviewees in one way or another. However there are also some challenges resulting from the factor tree, that were not mentioned by the interviewees as an important challenge: Staying within budget for implementation, meeting audit requirements and designing an adequate plan for the implementation. On the other hand, there are some challenges that seem to be typical for the implementation of an AMS in this sector, as these have not been acknowledged in literature: the challenge of working up asset data quality and the distrust of the regulator.

Table 5: Comparison of challenges identified from literature and expressed by interviewees.

Challenges according to interviewees	#	Challenges from literature
Challenges related to realizing cultural changes	4	Managing organizational changes
Challenges related to current asset base data	4	-
Challenges related to the AMS fit in the organization / Formulating AM vision or objectives	3	Fitting system into organizational strategy/Setting adequate objectives
Challenges related to getting staff committed	2	Commitment from (unsatisfied) employees/management
Challenges not to become bureaucratic / burden staff with administrative work	2	Bureaucracy/documentation challenges
Challenges related to the multi interpretability of the norm	1	Lack of knowledge for implementing a management system
Challenges related to the transfer of AM knowledge to employees	1	Keeping the system active in organization
Challenges related to distrust of regulator	1	-

Positive effects of implementing an AMS:

- An all-embracing positive effect cited in most of the interviews is 'having the focus on the right things'. The AMS helps the organizations to gain control over the assets and their states and the

risks associated with them. Through the establishment of clear objectives they are able to determine what they want to achieve with them. This enables the grid operators to prioritize projects and budgets and make a more efficient financial planning.

- Some of the interviewees indicated that this 'focus' has resulted in realizing budget cuts or postponing planned projects, because some projects in the portfolio did not contribute to what the organization wants to achieve or the risks resulting from postponing the projects were under the set threshold. In other words, the financial efficiency has gone up. It is interesting that most of the grid operators have noticed improvements in their financial position because of the AMS, but that they did not mention this as a motivation, so the benefits were unexpected.
- The fact that the AMS helped the organizations to restructure their processes, roles and responsibilities has also contribute to the increased control. The resulting transparency facilitates decision making and both internal and external communication.
- Many of the identified factors from the literature study can be traced back to the mentioned positive effects from the interviewees. Furthermore, as can be concluded from the descriptions above, the factors are not mutually exclusive, but they complement each other and even overlap. The 'improved focus' is not specifically mentioned but consists of different factors, some of which were identified from literature as well. The improved insight in asset status seems to results from the AMS specifically, while an improved financial and competitive position and an improved employee morale are not recognized by the interviewees, even though they resulted from the literature study. More strikingly, interviewees did not acknowledge improved health and safety, which is also a factor that was filtered from MS literature.

Table 6: Comparison of positive effects identified from literature and expressed by interviewees.

Positive effects according to interviewees	#	Postive effects from literature
Improved focus on the right aspects	4	-
Improved budget prioritization / financial decision making	4	Improved control over/predictability of costs/cost optimization
Improved compliance / relation with regulator	3	Improved compliance/Improved relation with regulator
Improved internal structure / roles / responsibilities	3	Improved clarity of processes and responsibilities
Improved risk management	3	Improved risk management
Improved internal and external transparency	3	Improved public image
Improved insight in status of assets	2	-
Increased output of assets	2	Improved performance of assets
Improved communication with board / shareholders	1	Improved internal decision making
Improved ability to think strategically	1	Improved focus on continuous improvement
Improved knowledge of asset management	1	Improved awareness of AM/Improved AM quality
Improved structure for plan evaluation and realization	1	-

Negative effects of implementing an AMS:

- Most of the negative effects result from the earlier mentioned challenges. The necessary cultural changes, which result especially from the separation of the asset manager role and the service provider role, introduces friction between staff departments and demotivated employees. Whereas the service provider in the pre-AMS situation had quite some autonomy, most of it now has been moved to the asset management department. In most of the organizations, the service provider now has the feeling that the asset manager is constantly looking over the shoulder and it is stated that employees are demotivated because they are afraid of losing responsibility.

- Complexity and double work are also experienced because of the role separation. The introduction of the interfaces has transformed informal communication lines between different departments of the organization into formal communication lines, especially within the smaller grid operators. This has led to a situation in which the AM department and the service provider both reported on the same issues. It seems however that this is a temporary situation, because the grid operators that have worked with the system over a longer period of time, notice that these effects have vanished.
- The organizations mention some negative effects related to the norm itself, which can also be explained based on the experienced challenges. There is however not much consensus on the effects and it seems that every organization has its own frustration with the norm.
- The increased complexity due to the role separation seems to be a negative effect that is specific to the AMS. The wrong motivation for the implementation, often external pressure, is a phenomenon that is acknowledged in literature, but it is not gathered under negative effects and therefore it was not taken up in the tree. 'Too high expectations' is a negative effect identified from literature, but not recognized by the interviewees.

Table 7: Comparison of negative effects identified from literature and expressed by interviewees.

Negative effects according to interviewees	#	Negative effects from literature
Increased complexity and double work due to role separation	4	-
Increased friction and de-motivation of employees due to role separation	3	Dissatisfaction with organizational changes/ demotivated employees
Increased amount of discussions due to multi-interpretability of the norm	2	Multi-interpretability of norm
Increased amount of work due to bureaucracy of norm	2	Excessive documentation
System takes more time and manpower than expected	2	More time and manpower than expected
Norm is too rigid and excludes creativity / not dynamic enough to fit current society	2	Rigidness of standard
Systems gets not embedded due to wrong motivation	1	-
Norm does not take customer satisfaction into account	1	-

Critical Success Factors for implementing an AMS:

- Concerning the critical success factors most of the organizations agree on the important ones. Resulting from the difficulties that the grid operators experienced with implementing the cultural changes, they emphasize the criticality of acknowledging these changes from the beginning and

properly managing them by paying enough attention to the employees involved and offering them training and time to adapt.

- A detailed and pragmatic plan for the implementation goes hand in hand with this. Make a realistic timeframe for the implementation and assign enough and the appropriate manpower to the project.
- More critical success factors acknowledged by most interviewed organizations are related to the commitment of involved employees and staff departments and the necessity of having ambassadors within the organization to realize this. The grid operators generally mention the importance of at least one top manager among these ambassadors, because it puts in more weight to convince the staff.
- Most of the critical success factors are related to the implementation process as opposed to the system itself. This is a logical conclusion, seeing the fact that most of the grid operators experiences challenging situations and negative effects related to the how the system should be implemented into the organization and not directly to what is implemented. I use a quote of one of the asset managers to illustrate this: "The separation of the asset owner, asset manager and service provider is not an exotic construction, however the transition towards this construction is a very complicated and time and effort consuming process".
- Although the most mentioned critical success factors in the interviews are identified from literature as well, other CSF's from the interviews are not found in literature. Some of these promote to keep the organization of the implementation process internal and are in contrast to the involvement of external consultants, which is mentioned in literature. The external motivation by the regulator seems specific to the context of this research and is not recognized in the literature study.

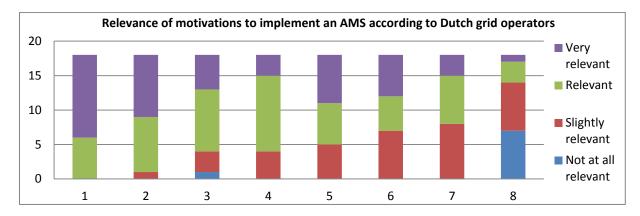
Table 8: Comparison of critical success factors identified from literature and expressed by interviewees.

Critical success factors for implementing an AMS	#	Negative effects from literature
Acknowledgement and management of necessary cultural changes	4	Management of cultural differences
Having a detailed and pragmatic plan for implementation	4	Pragmatic organization of implementation process
Commitment of involved employees and staff departments	3	Commitment of entire organization
Have ambassadors for the AMS to involve rest of organization	3	Middle management support/ Leadership
Initial situation of the organization	2	-
Decentralized design of processes to make interaction more informal	1	-
External motivation by regulator	1	-
Using internal staff members for the implementation process	1	-

5.2 Impact Factors Resulting from the Dutch Survey Respondents

A total of 18 respondents from 5 different Dutch grid operators finished the survey. All 5 Dutch grid operators are represented by 3 or 4 respondents. The results are presented in the figures below, divided into the five different categories of impact factors. The survey is added in Annex E. In the

tables below the graphs, the median of the dataset is determined, which is equal to the number in the middle of the data set, where 1 stands for 'not at all relevant', 2 for 'slightly relevant', 3 for 'relevant' and 4 for 'very relevant'. Also, after every category of questions a control question asks respondents to state any additional impact factors. The answers to these questions are also discussed here. In Annex F an overview is provided of the static data of the respondents of the survey.

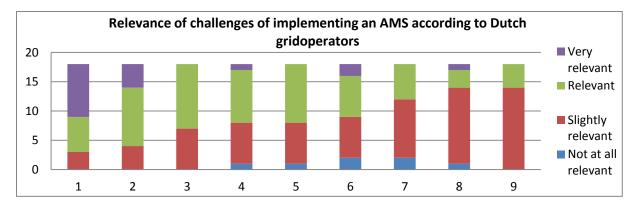


Rank	Impact factor	Not at all relevant	Slightly relevant	Relevant	Very relevant	Median
1	To improve control over and professionalize internal processes	0	0	6	12	Very relevant
2	To improve risk management	0	1	8	9	(Very) relevant
3	To meet regulator requirements	1	3	9	5	Relevant
4	To answer to a top-down management decision	0	4	11	3	Relevant
5	To increase performance and output of existing assets	0	5	6	7	Relevant
6	To reduce and/or optimize costs	0	7	5	6	Relevant
7	To improve the image towards the public and/or stakeholders	0	8	7	3	Relevant
8	To maintain or increase market share and improve competitive position of the organization	7	7	3	1	Slightly relevant

Figure 19: Survey results regarding the relevance of motivations from Dutch grid operators.

Motivations: Figure 19 shows that all of the 18 respondents from Dutch grid operators have indicated the motivation to improve control over and professionalize internal processes to be at least relevant, making it the most relevant motivation. The top three is completed by the motivation to meet regulatory requirements. 14 out of 18 respondents have rated this as at least relevant. The least relevant motivation is to maintain market share and improve the competitive position of the organization, which confirms the findings from the interviews and is to be expected as the sector is regulated and the organizations have a regional monopoly with their networks. However, costs reduction/optimization is rated as relevant in the survey results. This is different from the view created by the interviewees and indicates that the AMS is expected to lead to some financial benefits. 'To increase internal and external transparency' is the only additional motivation mentioned. This motivation was also mentioned by the interviewees.

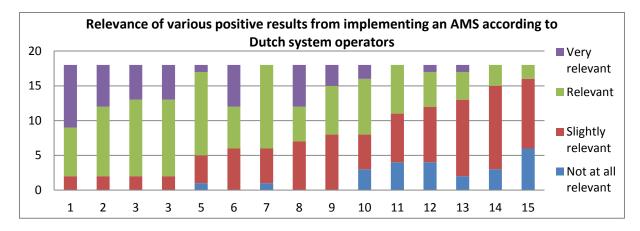
Master of Science Thesis



Rank	Impact factor	Not at all relevant	Slightly relevant	Relevant	Very relevant	Median
1	Challenges related to information of existing assets	0	3	6	9	(Very) relevant
2	Challenges related to organizational changes that come with the implementation of the AMS	0	4	10	4	Relevant
3	Challenges related to keeping the system up-to- date and active in the organization	0	7	11	0	Relevant
4	Challenges related to the fit of the asset management system in the existing organization	1	7	9	1	Relevant
5	Challenges related to the organization of the implementation process	1	7	10	0	Relevant
6	Challenges related to the lack of commitment to the AMS	2	7	7	2	(Slightly) relevant
7	Challenges related to meeting requirements for audits and assessors for the AMS	2	10	6	0	Slightly relevant
8	Challenges related to setting adequate asset management goals and objectives	1	13	3	1	Slightly relevant
9	Challenges related to the lack of necessary knowledge for implementing a(n) (A)MS	0	14	4	0	Slightly relevant

Figure 20: Survey results regarding relevance of challenges from Dutch grid operators.

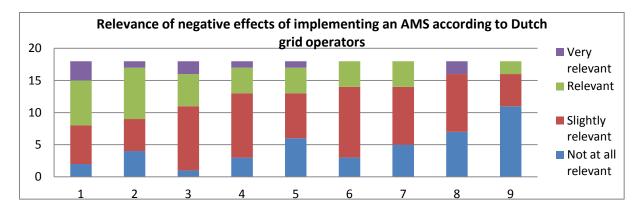
Challenges: Out of the challenges of implementing an AMS the most relevant ones turn out to be related to the information of the existing asset base of grid operators. The asset management norms require from the organizations that they work up the quality of the data of their assets, because quality data is necessary to base risk matrices and financial decisions on. However, information on assets has been lost during mergers of smaller grid operators into larger ones. The second most relevant category of challenges comes from the necessary organizational changes. 78% of the respondents has indicated these challenges as at least relevant. What stands out from these results, is that none of the challenges are irrelevant and six out of nine of the challenges are rated as at least relevant by at least half of the respondent. Furthermore, it seems that difficulties with meeting the requirements set by the norms were only minor and that sufficient knowledge for implementing the system was available within the organization. No additional factors are mentioned.



Rank	Impact factor	Not at all relevant	Slightly relevant	Relevant	Very relevant	Median
1	Improved control over and transparency in internal processes	0	2	7	9	(Very) Relevant
2	Improved risk management	0	2	10	6	Relevant
3	Improved focus on/awareness of Asset Management	0	2	11	5	Relevant
4	Improved ability to show compliance	0	2	11	5	Relevant
5	Improved knowledge of existing assets	1	4	12	1	Relevant
6	Improved controllability and predictability of costs	0	6	6	6	Relevant
7	Increased focus on continuous (technological and procedural) improvement	1	5	12	0	Relevant
8	Improved financial decision making	0	7	5	6	Relevant
9	Higher performance of assets	0	8	7	3	Relevant
10	Cost reduction	3	5	8	2	Relevant
11	Improved morale and motivation of workforce	4	7	7	0	Slightly relevant
12	Improved health and safety	4	8	5	1	Slightly relevant
13	Improved public image and customer satisfaction	2	11	4	1	Slightly relevant
14	Improved finance opportunities	3	12	3	0	Slightly relevant
15	Improved business opportunities	6	10	2	0	Slightly relevant

Figure 21: Survey results regarding relevance of positive effects from Dutch grid operators.

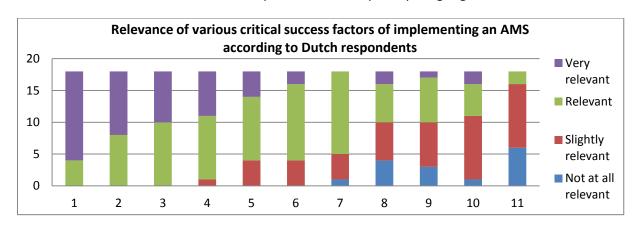
Positive results: The improved control over and transparency in internal processes is the most relevant positive effect of implementing the AMS according to the Dutch respondents. 16 out of 18 assess this effect as relevant or very relevant. This means that the AMS has met their expectations, seeing that the most relevant motivation was to improve this. More relevant positive effects are improved risk management, improved focus and awareness of asset management and improved ability to show compliance. Also, the effort in working up the quality of the asset data has resulted in improved knowledge of the existing assets. With regard to financial aspects it seems that the improvement of financial planning and cost reductions have been experienced to some extent and improved financial and business opportunities have hardly been registered. No additional positive effects were suggested.



Rank	Impact factor	Not at all relevant	Slightly relevant	Relevant	Very relevant	Median
1	The implementation process takes or has taken a lot more time and manpower than expected	2	6	7	3	Relevant
2	The implementation of an AMS forces the organization into compliance	4	5	8	1	Slightly relevant
3	The norm or standard relies too heavily on people and their interpretation	1	10	5	2	Slightly relevant
4	The implementation of the AMS has led to bureaucratization	3	10	4	1	Slightly relevant
5	The AMS introduces more complexity in the organization.	6	7	4	1	Slightly relevant
6	The standard procedures are too rigid	3	11	4	0	Slightly relevant
7	The implementation process has cost a lot more than expected	5	9	4	0	Slightly relevant
8	People were demotivated by organizational changes resulting from implementing the AMS.	7	9	0	2	Slightly relevant
9	Expectations of the AMS were too high	11	5	2	0	Not at all relevant

Figure 22: Survey results regarding relevance of negative effects from Dutch grid operators.

Negative effects: The scores for the relevance of the negative effects are relatively low, suggesting that the respondents are too positive, not many negative effects come from implementing an AMS, or other negative effects are applicable that were not among the survey questions. However, in the open question no additional negative effects are mentioned. The highest scoring negative effect is the extra time and manpower that was necessary for the implementation process. Furthermore, many of the respondents feel that the implementation of the system forces the organization into compliance, which they thus perceive as a negative effect. Another striking results, is that 11 out of 18 respondents indicated that it is not all relevant that expectations of the AMS were too high. This indicates that the AMS has fulfilled the expectations of the participating organizations.



Rank	Impact factor	Not at all relevant	Slightly relevant	Relevant	Very relevant	Median
1	Effective leadership by top management team	0	0	4	14	Very relevant
2	Commitment of entire organization or asset management departments	0	0	8	10	Very relevant
3	Middle management support/commitment for the AMS	0	0	10	8	Relevant
4	Intrinsic motivation	0	1	10	7	Relevant
5	The organization of the implementation process	0	4	10	4	Relevant
6	Extrinsic motivation	0	4	12	2	Relevant
7	Training and education of staff	1	4	13	0	Relevant
8	Working with a certifying body at an early stage	4	6	6	2	Slightly relevant
9	Managing the cultural differences in the organization	3	7	7	1	Slightly relevant
10	Experience in implementing other management systems	1	10	5	2	Slightly relevant
11	Involvement of external consultants	6	10	2	0	Slightly relevant

Figure 23: Survey results regarding relevance of critical success factors from Dutch grid operators.

Critical success factors: Many suggested critical success factors were indicated as being relevant. From the average scores it appears that top management showing leadership in the project is very relevant. Especially in combination with the commitment of everyone involved and the support by middle management. Intrinsic motivation is deemed more relevant than extrinsic motivation. This is a confirmation of what is claimed in literature concerning the successful implementation of management systems, but many respondents have also indicated the importance of external pressure. 14 out of the 18 respondents indicate that the organization of the implementation process is relevant or very relevant. Finally, the only suggested factor that scores below 'slightly relevant' is the involvement of consultants. This is quite striking as many difficulties have been reported with the interpretation of the norm and most interviewees confirmed having used some kind of external support. One additional critical success factor that is mentioned is the creation of ownership among employees to make the implementation a sustainable and lasting change.

5.3 Comparison of Impact at Dutch and Foreign Grid Operators

The survey was also sent out to foreign grid operators. A total of 16 respondents filled in the survey. All respondents have an asset management system in place, although not all systems are certified. These grid operators are TSO or DSO of electricity and/or gas grids in Switzerland, Brazil, Ireland, UK, Germany, India, Slovenia, South Africa, Finland, Spain, Belgium or Iceland. All respondents had relevant asset management functions at these organizations, so they are deemed able to answer the questions. The following figures display the distributions of the responses of Dutch and foreign grid operators per category of impact factors. Based on the fact that grid operators in other countries have similar functions, the hypothesis is that the impact of implementing an AMS is perceived similarly among Dutch and foreign grid operators. However, more privatized markets or a lower or higher maturity in asset management in other countries might result in differences. In the tables the differences between the results are tested on significance.

The Mann-Whitney U test is used to assess the differences and similarities of the different sample groups of respondents, for example the Dutch and foreign respondents. This test assumes no specific probability distribution function and is a non-parametric statistical test for independent samples. The null-hypothesis is that the two independent samples of observations are drawn from the same distribution and the alternative hypothesis assumes that one of the two samples has significant higher or lower values than the other one. The critical value U is calculated by the following formula and the smallest value of U_1 and U_2 is used to test for significance:

$$U_1 = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1$$

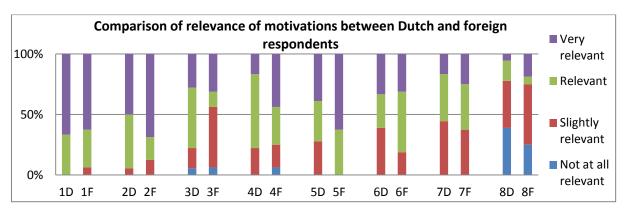
$$U_2 = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2$$

Where:

 $n_1 = size \ of \ sample \ 1$ $n_2 = size \ of \ sample \ 2$ $R_1 = Sum \ of \ the \ rankings \ in \ sample \ 1$ $R_2 = Sum \ of \ the \ rankings \ in \ sample \ 2$

Motivations: The motivations for implementing an AMS appear to be quite similar between Dutch and foreign grid operators. The largest differences based on the z-value are found in the motivations to meet regulatory requirements and increase the performance of the assets. Foreign grid operators assign a lower relevance to the motivation to meet regulatory requirements. Asset management experts have expressed that the pressure from the regulator is higher in the Netherlands than in most other countries and that in the United Kingdom for example the sector has somewhat more private characteristics compared to the Dutch sector. It seems therefore in line with the expectations that Dutch grid operators assign a higher value to this motivation. The differences between the two distributions is however not significant.

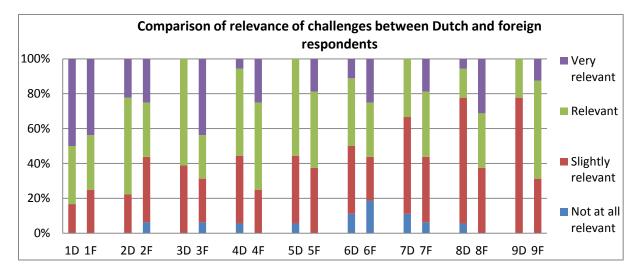
The difference between the assigned relevance to the motivation to improve the performance of assets is significant. Foreign grid operators are significantly more motivated to improve the performance of assets, better yet this is their highest ranked motivation. This might indicate that the Dutch grid operators are more realistic or more pessimistic about the effects of implementing the AMS. It is however more plausible, that the performance of foreign grid operators can in fact improve more. Many of the interviewees including the Dutch regulator have indicated that the performance of electricity and gas grids in the Netherlands is high compared to other countries.



Rank	Impact factor	U1 (Foreign)	U2 (Dutch)	Z-value	Significant (α=0,10)
1	To improve control and professionalize internal processes	153	135	-0,311	No
2	To improve risk management	123,5	164,5	-0,707	No
3	To meet regulator requirements	173	115	-1,001	No
4	To answer to a top-down management decision	119	169	-0,836	No
5	To increase performance and output of existing assets	95	193	-1,691	Yes
6	To reduce and/or optimize costs	126,5	161,5	-0,604	No
7	To improve image towards the public and/or stakeholders	129	159	-0,518	No
8	To improve market share/ competitive position	122	166	-0,759	No

Figure 24: Comparison of relevance of motivations between the Dutch and foreign respondents.

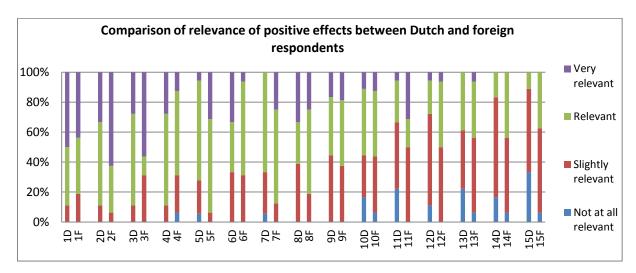
Challenges: Except for the first two challenges in the ranking, all challenges are assigned a higher relevance by the foreign grid operators than by the Dutch. The foreign grid operators seem to have had significantly more difficulties with setting adequate AM goals and objectives and their lack of AM and AMS knowledge. Based on the AM literature and the interviewees, it can be concluded that asset management has received more attention in the Netherlands than in most other countries. This might indicate that there is more asset management expertise in the Netherlands and therefore these challenges were less relevant for the Dutch grid operators.



Rank	Impact factor	U1 (Foreign)	U2 (Dutch)	Z-value	Significant (α=0,10)
1	Challenges related to information of existing assets	157,5	130,5	-0.466	No
2	Challenges related to organizational changes	167	121	-0,794	No
3	Challenges related to keeping system up-to-date/active	98	190	-1,578	No
4	Challenges related to the fit of the AMS in organization	100	188	-1,518	No
5	Challenges related to organization of implementation	116	172	-0,966	No
6	Challenges related to the lack of commitment to the AMS	132,5	155,5	-0,392	No
7	Challenges related to meeting requirements for audits	101	187	-1,484	No
8	Challenges related to setting AM goals/objectives	78	210	-2,277	Yes
9	Challenges related to lack of knowledge of AM/AMS	73	215	-2,450	Yes

Figure 25: Comparison of relevance of challenges between the Dutch and foreign respondents.

Positive effects: Out of the 15 identified positive effects, four were rated significantly more relevant by foreign grid operators. They improved the knowledge on their existing assets more strongly, just as their focus on continuous improvement. These results support the previously made assumption that the gap between the knowledge and performance of most foreign grid operators before implementing the AMS and the requirements in the AM norms is larger than was the gap for Dutch grid operators. Thus there seems to be more to gain for most of the foreign grid operators. Furthermore, half of the foreign respondents scored the improved health and safety as an effect of implementing the AMS as at least relevant, which is significantly more than the Dutch. This difference could also be explained by a relatively high safety in the Netherlands, compared to most foreign countries, possibly as a results of the strict supervision of the regulator. Finally the foreign grid operators noticed more strongly that the AMS provided improved business opportunities. Almost 40% of the foreign respondents rated the improved business opportunities as relevant, against only 10% of the Dutch. More privatized markets for foreign grid operators might explain this difference, but more research on the differences in the market models between countries is necessary to support this claim. A final remark on these results, which is in line with expectations, is that one of the few positive effects that seem to be perceived stronger by the Dutch is the improved ability to show compliance, although this difference is not significant.

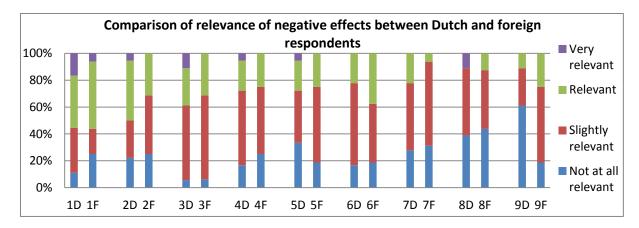


Rank	Impact factor	U1 (Foreign)	U2 (Dutch)	Z-value	Significant (α=0,10)
1	Improved control over/transparency in internal processes	157,5	130,4	-0,466	No
2	Improved risk management	102	186	-1,499	No
3	Improved focus on/awareness of Asset Management	128,5	159,5	-0,535	No
4	Improved ability to show compliance	185,5	102,5	-1,432	No
5	Improved knowledge of existing assets	87,5	200,5	-1,949	Yes
6	Improved controllability and predictability of costs	168	120	-0,828	No
7	Increased focus on continuous improvement	89	199	-1,898	Yes
8	Improved financial decision making	132	156	-0,414	No
9	Higher performance of assets	134	154	-0,345	No
10	Cost reduction	135,5	152,5	-0,293	No
11	Improved health and safety	93	195	-1,760	Yes
12	Improved public image and customer satisfaction	105,5	182,5	-1,328	No

13	Improved morale and motivation of workforce	121	167	-0,794	No	
14	Improved finance opportunities	99	189	-1,553	No	
15	Improved business opportunities	84	204	-2,070	Yes	

Figure 26: Comparison of relevance of positive effects between the Dutch and foreign respondents.

Negative effects: The disappointments with implementing the AMS are very similar between the Dutch and the foreign grid operators. All respondents seem to agree that the main disappointment is the amount of time and manpower that is necessary for the implementation of the system. This is the only negative effect that is rated as at least relevant by half of the respondents from both groups of grid operators. The only significant difference is in the perception of the expectations. Apparently, the foreign respondents had either higher expectations than the Dutch grid operators or the system has not lived up to their expectation as much as it did for the Dutch. From the motivations it appears that the foreign grid operators expected to increase the performance of their assets. When looking at the positive effects however, improved performance is not one of the top rated effects and the assigned relevance is similar to the Dutch. The foreign grid operators thus might have hoped for stronger performance improvements.



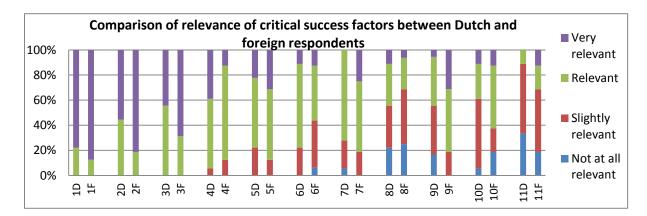
Rank	Impact factor	U1 (Foreign)	U2 (Dutch)	Z-value	Significant (α=0,10)
1	The implementation has taken more time/manpower	160,5	127,5	-0,569	No
2	The implementation forces the organization in compliance	169,5	118,5	-0,880	No
3	The norm relies too heavily on interpretation	160	128	-0,552	No
4	The implementation has led to bureaucratization	158	130	-0,483	No
5	The AMS introduces more complexity in the organization.	133,5	154,5	-0,362	No
6	The standard procedures are too rigid	128	160	-0,552	No
7	The implementation process has cost more than expected	164,5	123,5	-0,707	No
8	People were demotivated by organizational changes	151	137	-0,242	No
9	Expectations of the AMS were too high	82	206	-2,139	Yes

Figure 27: Comparison of relevance of negative effects between Dutch and foreign respondents.

Critical Success Factors: The relevance of most CSF's is similar to both groups of respondents and all respondents have rated the top three CSF's from the Dutch ranking as at least relevant. The only real difference lies in the relevance of management of cultural differences, which is rated significantly higher by the foreign grid operators. This is striking as the challenge of dealing with the necessary cultural changes resulting from implementing the AMS is rated one of the highest by both interviewees and Dutch respondents to the survey. Perhaps the question was not framed right and

Master of Science Thesis

'cultural differences' should have been 'cultural changes'. Both groups do seem to agree on the higher importance of having an intrinsic motivation compared to having an extrinsic motivation. A final note based on these results is the low relevance of involving an external party, like a certifying body or an external consultant, in the process. This is striking because most interviewees indicated that they have used this external support during implementation and foreign grid operators emphasized the lack of knowledge of asset management and asset management systems.



Rank	Impact factor	U1 (Foreign)	U2 (Dutch)	Z-value	Significant (α=0,10)
1	Effective leadership by top management team	130	158	-0,483	No
2	Commitment of entire organization or AM departments	107	181	-0,128	No
3	Middle management support/commitment for the AMS	109	179	-0,208	No
4	Intrinsic motivation	186	102	-1,449	No
5	The organization of the implementation process	123	165	-0,725	No
6	Extrinsic motivation	172	116	-0,966	No
7	Training and education of staff	103,5	184,5	-1,397	No
8	Working with a certifying body at an early stage	162	126	-0,621	No
9	Managing the cultural differences in the organization	73	215	-2,450	Yes
10	Experience in implementing other management systems	126,5	161,5	-0,604	No
11	Involvement of external consultants	104	184	-1,380	No

Figure 28: Survey results regarding relevance of critical success factors from foreign grid operators.

5.4 Comparison of Highest Ranked Impact Factors

In the tables below the results from the interviews are compared to the results of the survey. The top five of 'mostly-mentioned most-relevant impact-factors' in every one of the five categories of elements of impact are compared to the top five 'highest rated impact-factors on relevance' resulting from the survey. Obviously these are two different units of measurement and can hardly be compared. However, the tables merely support in the analysis of consistency of the general view of impact between the two information sources. For clarification, the rankings on the left are the answers on the open questions for the most relevant factors and not the answers chosen from a list of factors.

Table 9: Comparison of the most relevant motivations for implementing an AMS.

Most mentioned most relevant motivations in the Interviews	#	Most relevant motivations resulting from the Dutch survey respondents	Median
Motivated by some form of pressure from regulator	6	To improve control over and professionalize internal processes	Very relevant
Motivated by the urge to increase performance of assets in terms of safety and security	3	To improve risk management	(Very) relevant
Motivated by the urge to professionalize asset management and organization	2	To meet regulator requirements	Relevant
Motivated by the urge to be more transparent	2	To answer to a top-down management decision	Relevant
Motivated by the urge to have clearer processes, roles & responsibilities	2	To increase performance and output of existing assets	Relevant

The regulatory pressure appears as one of the most relevant motivations in both rankings. Furthermore, #3, #4 and #5 from the interview ranking seem to be part of the #1 motivation in the survey ranking to improve control over and professionalize internal processes. Also the motivation to increase performance corresponds in the two rankings. Risk management has in contrast a high ranking in the survey results, while it is not specifically mentioned in the interviews. However, one could argue that improve risk management is part of improving performance of assets in terms of safety. Overall, the rankings from the two sources of information match quite well.

Table 10: Comparison of the most relevant challenges for implementing an AMS.

Most mentioned most relevant challenges in the Interviews	#	Most relevant challenges resulting from the Dutch survey respondents	Median
Challenges related to realizing cultural changes	4	Challenges related to information of existing assets	(Very) relevant
Challenges related to current asset base data	4	Challenges related to organizational changes that come with the implementation of the AMS	Relevant
Challenges related to the AMS fit in the organization / Formulating AM vision or objectives	3	Challenges related to keeping the system up-to- date and active in the organization	Relevant
Challenges related to getting staff committed	2	Challenges related to the fit of the asset management system in the existing organization	Relevant
Challenges not to become bureaucratic / burden staff with administrative work	2	Challenges related to the organization of the implementation process	Relevant

The challenges in both rankings seem to correspond to a lesser extent than the motivations. There is consensus on the two most relevant challenges and on the difficulties with the fit of the system in the organization in both rankings. However the other challenges vary. When looking at the complete lists of challenges, especially resulting from the survey, one notices that most all challenges are perceived as at least relevant and the extremes do not vary that much. This indicates that most of the challenges have been experienced by all grid operators to some extent and, as was already concluded from the interviews, every organization has its own frustrations with the implementation and/or the norm.

Table 11: Comparison of the most relevant positive effects of implementing an AMS.

Most mentioned most relevant positive effects in the Interviews	#	Most relevant positive effects resulting from the Dutch survey respondents	Median
Improved focus on the right aspects	4	Improved control over and transparency in internal processes	(Very) relevant
Improved budget prioritization / financial decision making	4	Improved risk management	Relevant
Improved compliance / relation with regulator	3	Improved focus on/awareness of Asset Management	Relevant
Improved internal structure / roles / responsibilities	3	Improved ability to show compliance	Relevant

Improved risk management 3 Improved knowledge of existing assets Relevant

The improvements in budget prioritization and financial decision making, claimed by the interviewees, are not confirmed by the results from the survey as one of the most relevant positive effects. The relevance of other factors is confirmed in both rankings, although in different positions. The improved risk management, focus on asset management, compliance and internal professionalization all appear in both rankings. Most interviewees and respondents thus emphasize the relevance of these factors, but they are not rated as very relevant by most survey respondents. This indicates that the effects are not that strong.

Table 12: Comparison of the most relevant negative effects of implementing an AMS.

Most mentioned most relevant negative effects in the Interviews	#	Most relevant negative effects resulting from the Dutch survey respondents	Median
More complexity and double work due to role separation	4	The implementation process takes or has taken a lot more time and manpower than expected	Relevant
Friction and demotivated employees due to role separation	3	The implementation of an AMS forces the organization into compliance	Slightly relevant
Norm is multi interpretable and leads to discussions	2	The norm or standard relies too heavily on people and their interpretation	Slightly relevant
Norm is bureaucratic and leads to extra work		The implementation of the AMS has led to bureaucratization	Slightly relevant
System takes more time and manpower than expected	2	The AMS introduces more complexity in the organization.	Slightly relevant

The only negative effect with the median 'relevant' is the unexpected extra amount of time and effort for the implementation. This factor is also mentioned by some of the interviewees. Bureaucracy, the complexity and multi-interpretability of the norms also correspond in both rankings.

Table 13: Comparison of the most relevant critical success factors for implementing an AMS.

Most mentioned most relevant critical success factors in the Interviews		Most relevant critical success factors resulting from the Dutch survey respondents	Median
Acknowledgement & management of necessary cultural changes	4	Effective leadership by top management team	Very relevant
Having a detailed & pragmatic plan for implementation	4	Commitment of entire organization or asset management departments	Very relevant
Commitment of involved employees and staff departments	3	Middle management support/commitment for the AMS	Relevant
Have ambassadors to involve rest of organization	3	Intrinsic motivation	Relevant
Initial situation of the organization	2	The organization of the implementation process	Relevant

The critical success factors correspond quite well. The counterpart of the acknowledgement & management of cultural changes was formulated as: 'Actively managing the cultural differences during the implementation'. This factor was not scored with the same relevance as the relevance that becomes apparent from the interview ranking. Perhaps the fact that the factor says 'cultural differences' instead of 'cultural changes' has misled the respondents a bit, or the ranking from the interviews is too high. The importance of commitment is confirmed by both rankings and having ambassadors to involve the organization in the process is assumed to correspond to effective leadership as multiple interviewees indicated that someone from top management has to be ambassador of the system to get the system embedded in the organization. Furthermore, the importance of a pragmatic organization of the implementation process is also clear from both rankings.

Overall, the impact-views of the Dutch grid operators resulting from both sources of input, the interviews and the survey, correspond fairly well. Although the relation between the factors in one ranking and the other is not always obvious, with the additional and in-depth information from the interviews it is in most cases possible to find the common ground.

5.5 A Visualization of Impact of implementing an AMS

The most important effects of implementing an AMS are now identified and validated, based on data triangulation of the interviews and the survey results from both the Dutch and foreign respondents. The following figure visualizes where this impact of implementing asset management systems is focused, by combining the visualizations of all interviews with grid operators, which are presented in Annex H. The visualization scheme that was introduced in Chapter 1 is filled with colored circles, each color representing one of the five categories of impact. The positions of the factors on the crossing of a category of impact and the aspects that are influenced are determined based on the in-depth information provided by the interviewees and the interpretation of the researcher. The numbers within the circles represent the number of factors that have been mentioned by interviewees influencing the organizational aspect on the left. The number does not necessarily exist of all different factors, but could also include notifications of the same factor by different interviewees.

Besides the separation between company values and the other values, which are considered preconditions for the existence of almost any company, some more distinctions are made in the figure. The impact is divided into the impact of the system itself and the impact of the transition on the organization. In other words, a distinction is made between 'what' is implemented and 'how' it is implemented.

Furthermore, the impact of the system itself is subdivided into a positive influence and a negative influence. Based on the insights from the interviews, the following is assumed:

- Motivations indicate that the organization expects that the implementation of the system will have a positive influence on the related company aspects;
- Challenges indicate that the organization have indicated that these factors can have a negative influence on the related company aspects of they are not properly dealt with;
- Positive effects indicate that the factor has a positive influence on the related company aspects;
- Negative effects indicate that the factor has a negative influence on the related company aspects;
- Critical success factors indicate that the application of the factor either enhances the positive influence or reduces the negative influence on the related company aspects.

In general it appears from the figure below that most of the impact factors have influence on the organizational effectiveness and employee satisfaction of the organization. The company value that is most influenced is the regulatory compliance. Most of the positive influence is focused on organizational effectiveness and secondly on the regulatory compliance, while most of the negative influence is focused also on organizational effectiveness and employee satisfaction. Almost all critical success factors mentioned have to do with reducing the negative effects on the employee satisfaction and organizational effectiveness and they all seem to be related to how the implementation process should be organized.

Figure 29 can be separated into five different parts of the figure: 1. The positive influence of the system on company values; 2. The positive influence of the system on preconditions for existence; 3. The negative influence of the system on company values; 4. The negative influence of the system on preconditions for existence and finally; 5. The influence of the transition on the organization. These separate aspects will be discussed below.

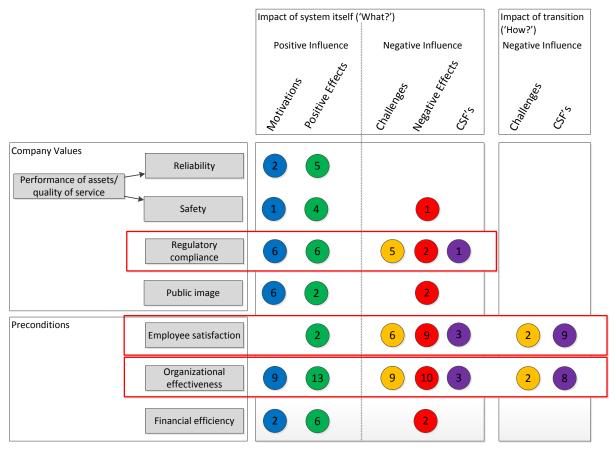


Figure 29: A visualization of where the impact of implementing an AMS at grid operators is focused (Own ill.)

5.5.1 Positive Influence of the System on Company Values

Motivations and positive effects are spread out over all values and preconditions. In relation to the company values most factors influence the regulatory compliance. As the improved ability to show compliance is also one of the most relevant positive effects, this indicates that a important part of the impact is located there. Most of the positive influence on the performance of assets exists of the improved risk management, which is also one of the most relevant factors resulting from the data triangulation. Although risk management is expected to eventually have a positive influence on the performance, an actual increase in the output of assets has only been mentioned by one of the interviewees and does not come out as one of the most important positive effects. It also appears that the public image is hardly impacted positively by the implementation of the AMS, although multiple grid operators have mentioned a motivational factor that would positively influence this public image.

5.5.2 Positive Influence of the System on the Preconditions

The bulk of the positive influence of implementing the AMS seems to be focused on the organizational effectiveness. Obviously, this term is much broader than a value like safety or reliability and thus it to be expected that it includes more impact factors. However, interviewees and

survey respondents seem to agree on the most important factors influencing this precondition. The positive impact mainly exists of professionalization of the internal organization by an improved structure of roles and responsibilities, increased transparency and more effective and efficient decision making. Other factors that influence the organizational effectiveness are the increased knowledge of the assets and focus on AM. The financial efficiency of the organization is also positively influenced by the implementation of the AMS. This is mainly reflected by budget prioritization based on risk assessments. The improved financial efficiency is however not confirmed by the survey results as one of the most important effects.

5.5.3 Negative Influence of the System on Company Values

There seem to be hardly any negative effects of implementing the system on the company values of the grid operators. The main influence in this part of the impact is formed by the challenge to work up the quality of the asset data, which is a requirement both from the system and from the regulator. Moreover, the triangulation of the most relevant impact factors showed that this is indeed one of the most important challenges.

5.5.4 Negative Influence of the System on the Preconditions

The main part of the negative influence of the system on the preconditions is focused on the organizational effectiveness and the employee satisfaction. The negative effect of the challenges on the organizational effectiveness mainly resides in working up the quality of asset data. The implementation of the system forces the organization to separate the role of asset manager from the service provider. This has caused friction between the departments, de-motivation of employees but above all this increased the complexity and introduced double work and inefficiencies. Also the extra amount of time and manpower has negatively influenced the financial efficiency and the organizational effectiveness. When incorporating the results from the survey, it appears that these factor are acknowledged, but they are only slightly relevant to the bulk of the respondents. The impact of these negative effects seems therefore limited. The critical success factors in this part of the visualization are the acknowledgement and the management of the changes in the organization that are required by the system, which impact both the organizational effectiveness and the employee satisfaction.

5.5.5 Influence of Transition on the Organization

Many of the factors mentioned by the employees do not directly follow from implementing the system itself, but they are rather related to the transition. Most of the studied literature acknowledges difficulties of a transition phase, but does not make an explicit distinction between the impact of the system and the transition. From the figure it shows, that the impact of the transition only exists of challenges and critical success factors. The influence on the organizational effectiveness exists of the challenges of how to fit and embed the changes of the transition into the organization. The employee satisfaction comes under pressure from the challenges of how to get the staff committed to the changes. The bulk of the critical success factors are thus indications of what is necessary to deal with these challenges, like attention for the involved staff and effective leadership. These CSF's also come out as most important impact factors from the interview and survey results.

The separation of the impact of the system and the transition is visualized to indicate that an important portion of the challenges is not related to the system, but to the management of change in general. Moreover, almost all CSF's are focused on how to deal with the transition. These challenges

and CSF's are acknowledged widely in the implementation of other management systems (Annex C) and still the same mistakes are made, like taking too little time for the implementation process.

5.6 Validation of Results on Impact of Implementing an AMS

Now that the impact of implementing an AMS for grid operators has been established in terms of its most important impact factors and where this impact is focused within the organization, some additional analyses are performed to test the robustness of the results. The effect of time on the effects of the AMS is investigated and the impact is also studied from another perspective.

5.6.1 The Effect of Time on Perceived Impact

Most advocates of asset management agree that only after three years of practicing asset management consistent performance advantages can be registered (Hodkiewicz, 2014). The grid operators under study started practicing asset management in different points in time. Some of the interviewed organization have started implementing asset management procedures from 2004, while others only started in 2011. Also, one organization received certification for its AMS in 2005 while there are also grid operators that have not yet been certified, even in the Netherlands. Because of the claim by the asset management advocates and the different levels in asset management maturity that the organization are in, it is interesting to see what the effect of time is on the effects of implementing an AMS.

To be able to compare the results of the different organizations under study against the variable of time, the year of certification is taken as a calibration point. Although certification for an AMS is not considered essential to be able to measure results from an AMS, it is a useful moment for comparison, because getting certified means that the AMS satisfies the requirements of an independent norm according to endorsed certifying institutes. The total group of respondents is divided into organizations that have received certification before 2011 and organizations that got the certificate after 2011. The perceived relevance of positive and negative effects for these two groups, called the before-group and the after-group, is compared. For the Dutch organizations of which multiple respondents had filled in the survey, the median of those results is taken as one respondent. The before group has a size of 10 respondents and the after group has a size of 7 respondents. The results are displayed in Annex I. As the respondents were asked to rate the relevance of motivations before the implementation, so at a certain point in time, and the challenges and CSF's are mainly related to the implementation process only, the effect of time on these categories is not considered interesting and is therefore not taken into account.

Positive effects: The positive effects are rated very similar between the before and after groups. Only the improved morale and motivation of the workforce and the improved health and safety are rated significantly higher by the before group. As these effects were not ranked high by either the Dutch or the foreign respondents, the effect of time on the benefits of implementing an AMS seems to be very minimal. This is in contrast to the expectations of interviewees from organizations that just received certification for their system and to the claims made by some of the organizations that have been certified for a longer period. Furthermore, one would expect that the positive results will come out stronger, once the initial problems with the system are solved and the organization is familiarized with the system. A possible explanation is that the system does not get embedded in the organization and that after a while staff continues to work according to former procedures. Another explanation could be that, because of the very long lifetime of the assets in this sector, most positive

effects like cost reduction and increased performance of assets, only surface after a longer period than 3 years.

Negative effects: Only two of the negative effects are rated significantly lower in relevance by the before group, namely the effect that the expectations were too high and the increased complexity in the organization due to the AMS. The first effects could indicate that expectations are only fulfilled after some time after implementation, but this is not supported by the differences in relevance of positive effects over time. It could also indicate that the expectations are adjusted over time. The reduction of the complexity over time is in line with the expectations, as the organization should get used to the new structure. Some factors are not expected to change or would even increase over time, like the amount of time, manpower and money spend on implementing the system. One would expect however the effects of for example multi-interpretability or rigidness of the norm and the demotivation of staff due to the introduced changes would also reduce over time. However, this does not seem to occur. A possible explanation is that the interval of measurement is too short to be able to measure a difference.

5.6.2 The Effect of Time on Asset Performance

From the results in this research, it seems that not all of the, by publishers of the norms claimed benefits of implementing an AMS are experienced by all grid operators and that most of the positive effects are focused on less clearly defined aspects of the organization, like operational excellence. In contrast to some other company values and preconditions in Figure 29, asset performance can be easily measured. Performance of assets in this sector consists of reliability and safety and can be determined by the outage minutes per customer and the number of incidents. Although performance improvements of the assets is not one of the highest ranked effects, some of the Dutch grid operators still claim that this performance has improved as a result of implementing the AMS.

In Figure 30 the losses of electricity over the grid as a percentage of the total usage of electricity in the Netherlands is shown over the years 2000 until 2013, of which 2013 is still preliminary. If performance of the grids would have increased in terms of the reliability of the assets, losses over the grid might have decreased. The percentage is fairly constant and even rising a little bit over the last three years. The reason for the dip between 2008 and 2011 is unknown. The figure does not support the potential increase of performance of the assets in terms of reliability.

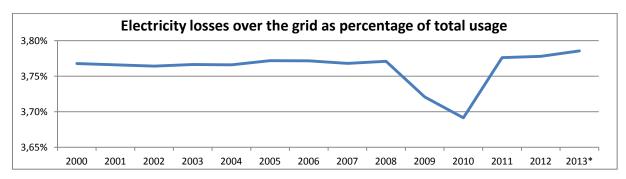


Figure 30: Electricity losses from 2000 until 2013 (CBS, 2014).

The first Dutch grid operator received certification for their asset management system in 2005. This organization claims to have increased the performance of their assets, in terms of reliability and safety. The unit of measurement that the grid operators use for the reliability of their grids is the average number of minutes per year that a consumer connected to their grid cannot be supplied

with electricity or gas. As has been mentioned, Dutch grid operators are required to produce a quality and capacity document once every two years, in which they present how they will reach the pursued quality and satisfy the transport capacity demand for the coming years. The figures below results from these documents.

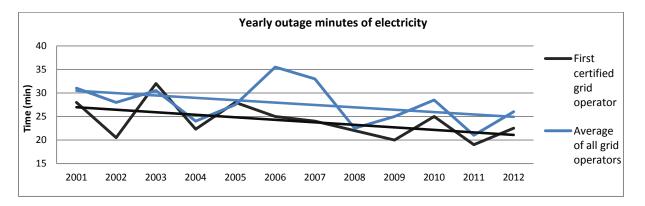


Figure 31: The yearly outage minutes of the first certified grid operator for their electricity (Enexis, 2014).

The yearly outage minutes are the outage minutes of the power grids divided by the number of customers affected. This figure does not confirm the claims by grid operator about their increased reliability, but it also does not reject them. There is a decrease of the yearly outage minutes of both the specific grid operator and the average of all grid operators. This indicates that the sector as a whole has been performing better since 2001, especially when it is considered that the asset manager from the specific grid operator claimed that when no maintenance or replacement of the existing grids is executed the outage minutes would increase by 2 minutes per year. For the specific grid operator, the reduction of outage minutes from 2005 could be the results of the implementation of the AMS, but this is untraceable from these data. More specific information on outages and regions is necessary to determine whether the AMS has indeed contributed to the increased performance in terms of outage minutes. The failures of the power grids leading to the outage minutes can have many different causes. One of the main causes of failures is the aging and/or wearing of the assets. As the interviewees indicated that the AMS has helped them to prioritize expenditures based on risk assessments, a reduction of outage minutes caused by this aging and/or wearing is expected. This should be investigated further, before real conclusions on the contribution of the AMS can be drawn.

5.6.3 Impact of Implementing an AMS from Different Perspectives

In order to validate the results from the triangulation of most relevant impact factors and the aspects of the organizations that are mainly influenced, a Dutch regulator and a renown certifying institute are interviewed to provide their view on the impact of implementing an AMS.

The SodM is a governmental regulator, supervising mining activities and the transport of natural gas. They are thus only involved with GTS and the parts of the regional grid operators that manage the gas grids. The SodM has embraced the NTA 8120 and asset management systems in general to a larger extent than the ACM. The interviewee at SodM was willing to take part in an interview and his view on impact is visualized in the following figure. One of the remarks made by the interviewee, is that the sector is very open about its business and performance and he expects that grid operators would not deliberately leave information out.

The interviewee at the certifying institute formerly worked as an assessor of asset management systems and was authorized to give out certifications, mostly in the utilities sector. Currently he works as a consultant in the same sector. Below his vision on impact of an AMS is displayed.

The overall conclusions of taking into account the perspectives of the SodM and the certifying institute, is that the focal points are on the same areas. Most factors influence the operational excellence and for both challenges and negative effects the second place for factors to accumulate is the employee satisfaction. No new factors have been mentioned, which is logical as these organizations base their opinions on what they have seen at the grid operators. The established view that was based on the interviews with grid operators and the survey results is mostly confirmed by these other perspectives. The regulator and certifying institute are at most somewhat more reserved in stating the positive effects. Below the interesting insights from these interviews are provided.

- 1. The certifying institute notifies that the external pressure from the regulator has kick-started the application of asset management in this sector. Compared to water utilities, some of which have started implementing an AMS over 5 years ago and still have not passed the implementation phase, grid operators are very mature in asset management procedures.
- 2. The challenges related to working up the asset data quality are very common among organizations owning capital-intensive assets, according to the regulator. This is striking, as it was assumed that this was caused mainly by the merging of multiple smaller grid operators into the organization as they are now. This seems however not specific to this sector.
- 3. A second category of challenges, related to aligning the objectives for the AMS with the strategy of an organization is also common to most utilities owning large and capital intensive assets. Interviews at grid operators indicated that they had hardly any problems with this, but from the survey results this challenge came out as one of the most relevant. It was assumed that setting objectives for an AMS is quite straightforward for these organizations, because their main objective is to operate and maintain large assets. The representative of the certifying institute mentioned however that problems arise when a CEO of the organization sets objectives for his own term, while the assets have a much longer lifetime. The uncertainty about the role of the grid operators in the future and about the use of the grids might also play a role in this challenge.
- 4. Neither the regulators, nor the certifying institute has noticed any cost reductions or improved performance, while these positive effects have been claimed by grid operators. The SodM for example states that the asset management norms do not mention how to bring down the number of health incidents specifically and therefore he still has to experience this effect.
- 5. A remark related to the effect of the AMS on the performance of assets, made by a representative of another regulator is that the norm misses the link between management related processes and the content requirements for the task of the regulator. Although the NTA 8120 is specifically written for the grid operators, according to this representative still substantive information is missing in the norm and this makes it difficult to align the objectives of the system with the objectives of the grid operator.

6 Conclusions and Discussion

This chapter addresses the main conclusions with respect to the impact of implementing an asset management system at grid operators, based on the research questions that were defined in the introduction. It also discusses the implications of the conclusions for the asset management community and reflects on the methodology and the conclusions of this research. Finally, the chapter provides suggestions for further research.

6.1 Conclusions of research based on Research Questions

The main research questions was formulated as follows:

"How to create insight in the impact of implementing an asset management system (AMS)?"

This question is answered step by step by assessing the sub-questions.

1. What does impact mean in relation to the implementation of a(n asset) management system?

Impact has been defined, based on a literature study on the impact of management systems and a context-study on the sector of power and gas grid operators. This has resulted in a schematic representation of the definition of impact. The impact of implementing an AMS at grid operators exists of different impact factors in five different categories, influencing four company values applicable to all organizations in the sector and three preconditions for existence of every organization. This has resulted in Figure 16.

2. What are possible impact factors of management systems, based on existing literature?

Possible impact factors have been filtered from the literature study on impact of management systems and asset management literature. All the factors fall under one of the five categories in the figure above. Literature related impact of management systems proved to be a valuable starting point for the research, as many of the resulting important impact factors of implementing an AMS are similar to the identified factors from the literature study. The impact factors have been assembled in the table in Annex C and subcategorized in the factor trees in §2.5.

3. What is, based on existing management system literature, a suitable methodology to assess the impact of asset management systems?

Based on the findings from the literature study and the context-study, a combination of semistructured interviews and an online survey with both Dutch and foreign grid operators was applied in this research. Furthermore, several checks with asset management and survey experts were incorporated in the research approach, which is visualized in Figure 18. Data from the interviews, the Dutch and the foreign respondents to the survey were combined by triangulation of the most important impact factors. Finally the results were validated by the analyses of statistical data and by incorporating additional perspective from the sector.

4. What are the most relevant impact factors according to electricity and gas grid operators?

The most relevant impact factors of implementing an asset management system are divided into the five categories, as presented in the table below, followed by a short explanation and conclusions on the impact of implementing an AMS.

Table 14: An overview of the most relevant impact factors of implementing an AMS at power and gas grid operators.

Category	Most relevant impact factors
Motivation	- To meet regulatory requirements;
	- To professionalize the internal structure and processes;
	- To increase the performance of assets;
	- To improve risk management.
Challenges	- Managing the cultural changes;
	- Working up the quality of the asset-data;
	- Aligning the objectives of the AMS with the strategy of the organization;
	- Embedding the system into the organization.
Positive effects	- Professionalization of the internal organization;
	- Improved risk management;
	- Improved regulatory compliance;
	- Improved focus on the management of assets.
Negative effects	 The system requires more time and manpower than expected;
	- Increased complexity due to role separation;
	- Bureaucracy;
	- Multi-interpretability of the norm.
Critical success factors	- Leading role of top-management in the implementation;
	- Middle management support;
	- Commitment of involved staff;
	- Pragmatic plan and planning for the implementation process.

Most grid operators felt both an internal and an external motivation to implement an AMS. Most of them expected an increase in performance from the assets, but have not registered this positive effect yet. The other motivations were satisfied by the positive effects. The grid operators have professionalized their organization with a clearer structure of roles and responsibilities. Also, the management of risks has been improved through the system, meaning that risks related to the assets are known, documented and assessed on their impact. These effects combined have increased the transparency of operation and facilitated financial decision making by top management. Because the grid operators can substantiate their decision and actions, there are also better able to comply with rules and regulations.

The role separation that is prescribed by the AMS norms between the AO, AM and SP forces these organization to change their way of working. These cultural changes have led to increased complexity, double work and friction between the AM and SP departments. Convincing the staff of the new procedures and securing their commitment proves to be a real challenge and has cost more time and manpower than expected. The AMS also requires the organization to get their asset information in order, but because part of this information is lost or non-existent this proves to be a challenge as well. The norm is also said to be multi-interpretable in some aspects which leads to discussion within the organization and difficulties in setting adequate objectives for the system.

Results of the research point out a leading role of top management is essential for the implementation of the AMS, together with the support of the middle management, as these managers have to actively use the system. Attention for all employees involved, especially those affected by the cultural changes caused by implementing the AMS, is also crucial to get their commitment. Finally, a pragmatic plan and a realistic planning for the implementation process needs to be designed, if the organization wants to reduce or avoid some of the challenges and negative effects.

5. How can the impact of implementing asset management system be visualized/presented?

The impact of implementing an AMS is visualized by filling in Figure 29 with the impact factors mentioned during the interviews. The following main conclusions can be drawn from the visualization:

- Positive influence of the system primarily focuses on the organizational effectiveness of the internal organization and to a lesser extent on the company values of the grid operators, like the reliability and safety of assets;
- The negative influence of implementing the system is mainly focused at the organizational effectiveness and employee satisfaction in the organizations, while the negative influence of the company values seems very limited;
- A distinction can be made between the impact of the system itself and the impact of the
 transition that the organization goes through. The impact of the transition exists of challenges
 and critical success factors that are related to the management of the transition. These factors
 only influence the organizational effectiveness and the employee satisfaction of the
 organizations and show strong similarities with impact of other management systems.

6.2 Implications of Conclusions for Asset Management Community

This research has focused on the sector of grid operators. However, ISO 55000 is applicable to all types and sizes of organizations (ISO, 2014a). Therefore it is interesting to discuss the implications for the asset management community in general and to consider to what extent these results can be generalized and applied to other sectors and in different contexts as well.

- 1. Based on the results of this research, I conclude that most interviewed representatives and respondents of Dutch and foreign grid operators are satisfied with the impact that the implementation of the AMS has had on their organizations. Positive effects are generally assigned a higher relevance than the negative effects and some negative effects only seem to have a temporal character. This research can therefore be used as promotional purposes by the AM community towards organizations that are considering the implementation of an AMS. Furthermore, it provides insights into what can be expected of the implementation process and the system itself.
- 2. This research shows that grid operators, who have been working with asset management systems for almost a decade, have registered mainly positive effects on the internal organizational effectiveness. Although increased financial and asset performance as a results of implementing an AMS are claimed by both the PAS 55 and the ISO 55000, these effects are not gathered among the most relevant positive factors so far. This means that in order to measure the impact of an AMS, methods should focus on measuring this organizational effectiveness. Based on the in-depth information of the interviews, indicators for this effectiveness could be: the reduced number of employees due to the restructuring; the reduction of time in management meetings spend on investment decisions; the reduction of time and money spend on failed or unnecessary projects; the increased completion rate of the project portfolio; and the investments saved or made due to the increased insight into asset-related risks.
- 3. The distinction between the impact of the system itself and the impact of the transition resulting from the implementation, points out that specific attention must be allocated to the organization of

the implementation process. In-depth information from the interviews showed that organizations had taken too little time for the implementation, paid too little attention to the involved staff and forced the system upon the organization. This is despite the fact that literature on critical success factors for implementing management systems indicate that sufficient time and commitment of the staff are essential for the organization (Annex C).

- 4. The results of this research can be generalized to some extent, based on the similarity of impact factors of implementing an AMS and other management systems. Furthermore, the representative of the regulator indicated that challenges and effects in the sector of grid operators are similar to the impact that was seen in other organizations owning large and capital-intensive assets. It is however questionable whether the increase in organizational effectiveness is satisfying for more commercial organizations. It is assumed that these organization would be particularly interested in improving the performance of their assets. Further research in a more commercial sector would have to be executed to support this.
- 5. Based on the significant differences between the results of the Dutch and foreign survey respondents, it seems that the Dutch grid operators have more asset management knowledge and are a step further in the maturity of asset management principles compared to the foreign grid operators. The foreign grid operators assigned a significantly higher relevance to challenges related to setting adequate asset management goals and to the lack of asset management knowledge. Furthermore, the experienced the increased knowledge of their assets, focus on continuous improvement and health and safety to a higher extent than the Dutch. This could indicate that the gap between the starting point of the organization and the requirements for an AMS is larger for most of the foreign grid operators than for the Dutch. Finally, foreign grid operators assigned a significant higher relevance to the factor that their expectations were too high, possibly indicating that Dutch grid operators had a more realistic view of what the AMS would bring their organization.

6.3 Reflections on Methodology and Conclusions

There are several reasons why the conclusions of this research have to be adopted with care, which are discussed below.

• All respondents of the survey represent organizations that are in different stages of the implementation process. Some organization have just started, others have just received certification for their systems and again others have been working with the system for multiple years. This raises an interesting discussion, as it is not completely clear from what moment on the relevance of impact factors has been assessed. The negative effect of some factor can be very relevant over the total period from the start of the implementation until the situation the organization is now in, but at the time of filling in the survey the effect can have been reduced to only slightly relevant, thus leading to a different answer. Part of this discussion can be solved by rephrasing the questions and asking respondents to indicate how relevant a factor has been since the start of the implementation process. It is however often not clear what the starting point is. It could be the first time 'asset management' was mentioned in a managers meeting, when the organization established a AM department or when they bought the AMS norm. Ideally, organizations under study would have started implementing an AMS at the same moment, so the results were also comparable on the aspects of time.

Master of Science Thesis

- Another aspect up for discussion related to the respondents of the survey, is the position of the respondent in the organization. Although from the static information of the respondents in Annex F, it appears that most of them have a function as asset-, grid- or risk manager, some seem to have a more senior function like the head of the department of AM or vice president. Again others are active in the technical or operational departments. It thus seems that respondents from the three different roles in the AMS, being the asset owner, asset manager and service provider have filled in the survey, while ideally for the comparability of results, respondents would have a similar position in the organizations. Representatives from different departments will likely have a different perspective on the impact of the AMS. Top managers could for example be much more focused on measurable results and, because those results have not yet surfaced, therefore be more negative on the impact of the AMS. Respondents active in the service provider could also be very negative about the system, as the cultural and organizational changes have affected mainly this department. Finally, asset managers might be over-positive, because they are the promoters of the system and really want to see the positive results. If all respondents have the same position the results can be corrected for this potential bias, based on in-depth information or objective data. This is more difficult for the results in this research.
- Some of the potential bias of survey respondents and interviewees has been attempted to be reduced by including the perspectives of the regulator and a certifying institute. Although the regulator would be expected to have an objective view, it cannot be said with certainty that this representative is without bias. The same goes for the certifying institute, especially because promotion of these type of systems could result in more work for the institute. For these reasons, this validation method has been of limited value.
- Another point of discussion resides in the maturity of asset management of some of the respondents. Although all respondents that were included in the results indicated that they have implemented an AMS, there is no unambiguous definition of an asset management systems. It is difficult to judge whether the respondents from Brazil and India have more or less the same understanding of an AMS as the grid operators in the Netherlands and the UK. It is therefore questionable whether these respondents perceive the questions similarly to the Dutch respondents. If they perceive the questions differently, or if they have a different definition of what an AMS is, then this could really affect the results. More research in the maturity of asset management at these organizations and in these countries is necessary to be able to assess this potential difference.
- Finally, results from Dutch respondents have been compared to results from foreign respondents, just as results from organizations that received certification before and after 2011.
 The sample groups of these comparison however, are relatively small. This reduces the value of the statistical tests on significance. Ideally, groups of respondents are much larger in order to have more certainty about the differences.

6.4 Recommendations for Further Research

This research has identified the most relevant factors of impact of implementing an asset management system and coupled these factors to the company values and preconditions of grid operators. Obviously, this research also gives rise to suggestions for further research. Some of these are discussed below.

- The analysis of statistical data of the outage minutes has been of limited value to the validation of the results in this research. However, it did point out that over the last decade, the number of outage minutes per year per customer has been brought down. Specific causes for grid failures can be reduced by the AMS, like aging and wearing of the assets. Further research into the causes of the reduction in outage minutes might provide evidence of the contribution of an AMS. Because of the public character of the sector, a lot of data on the performance of the grid operators is available. Further research into this objective data may assist is validating the findings from this research.
- In order to measure the impact of an AMS, the focus should be on the organizational effectiveness of the grid operators. According to Richard et al. organizational effectiveness can be measured by means of balanced scorecards, although these will have to be tailored to each individual firm (Richard et al., 2008). Another possibility is to use logic models, which is an approach to analyze the operations and results of programs (Wholey, Hatry, & Newcomer, 2010). A third possibility to measure the increase in effectiveness of the organization is monitoring the reduced number of employees due to the restructuring; the reduction of time in management meetings spend on investment decisions; the reduction of time and money spend on failed or unnecessary projects; the increased completion rate of the project portfolio; and the investments saved of made due to the increased insight into asset-related risks. These are all indicators of the increased effectiveness, as they have been mentioned as results by the interviewees.
- To strengthen the results from this research and to test the methodology in another context, applying this methodology in a different sector is recommended. This will enable a comparison of the most important impact factors between two sectors and support conclusions on the generalizability of the results.
- In this research, the focus has been on the impact of asset management systems according to the asset management departments of grid operators. However, to create an even broader picture, the opinions of top management and service providers might also be included. It is recommended to execute interviews with these departments as well.
- Only a fraction of all existing grid operators have been reached and even less have responded to
 the survey request. More respondents will enable more and higher quality statistical analysis,
 which can support the results and conclusions from this research. This is especially interesting for
 the analyses of the influence of time.

7 References

- ACM. (2013). Jaarverslag 2013.
- Amadi-echendu, J., Willett, R., Brown, K., Lee, J., Mathew, J., Vyas, N., & Yang, B. (2010). WHAT IS ENGINEERING ASSET MANAGEMENT?
- Anderson, C. (2005). How to build effective management systems. *Business Process Management Journal*. Retrieved September 04, 2014, from http://www.bizmanualz.com/blog/building-effective-management-systems-discovery.html
- Baarda, D. B., De Goede, M. P. M., & Teunissen, J. (1997). *Kwalitatief Onderzoek*. Stenferd Kroese.
- Beattie, K. R., & Sohal, A. S. (1999). Implementing ISO 9000: A study of its benefits among Australian organizations. *Total Quality Management*, 10(1), 95–106. doi:10.1080/0954412998090
- Biazzo, S., & Bernardi, G. (2003). Process management practices and quality systems standards: Risks and opportunities of the new ISO 9001 certification. *Business Process Management Journal*, 9(2), 149–169. doi:10.1108/14637150310468371
- Boulter, L., & Bendell, T. (2002). How can ISO 9000:2000 help companies achieve excellence?: What the companies think. *Measuring Business Excellence*, 6(2), 37–41. doi:10.1108/13683040210431455
- BSI Group. (2014). ISO 55000:2014 Asset Management -Optimize your assets and improve performance. Retrieved June 06, 2014, from http://www.bsigroup.com/en-GB/Asset-Management/
- Buttle, F. (1997). ISO 9000: marketing motivations and benefits. *International Journal of Quality & Reliability Management*, 14(9), 936–947. doi:10.1108/02656719710186867
- Cambridge University Press. (n.d.). Definition of impact noun. Retrieved June 24, 2014, from http://dictionary.cambridge.org/dictionary/british/impact_1
- Capability Maturity Model Integration. (2010). *Plays in Business*. Retrieved July 04, 2014, from http://plays-in-business.com/2010/12/cmmi-overview-1/?lang=en
- Carlsson, M., & Carlsson, D. (1996). Experiences of implementing ISO 9000 in Swedish industry. *International Journal of Quality & Reliability Management*, 13(7), 36–47. doi:10.1108/02656719610128547
- Casadesús, M., Giménez, G., & Heras, I. (2001). Benefits of ISO 9000 implementation in Spanish industry. *European Business Review*, 13(6), 327–336. doi:10.1108/EUM000000006195

- Casadesús, M., & Karapetrovic, S. (2005). Has ISO 9000 lost some of its lustre? A longitudinal impact study. *International Journal of Operations & Production Management*, 25(6), 580–596. doi:10.1108/01443570510599737
- CBS. (2014). Elektriciteitsbalans: aanbod en verbruik.
- Chow-Chua, C., Goh, M., & Wan, T. B. (2003a). Does ISO 9000 certification improve business performance? *International Journal of Quality & Reliability Management*, 20(8), 936–953. doi:10.1108/02656710310493643
- Chow-Chua, C., Goh, M., & Wan, T. B. (2003b). Does ISO 9000 certification improve business performance? *International Journal of Quality & Reliability Management*, 20(8), 936–953. doi:10.1108/02656710310493643
- Delta. (2014). Electriciteit Kwaliteit- en capaciteitsdocument.
- Douglas, A., Coleman, S., & Oddy, R. (2003). The case for ISO 9000. *The TQM Magazine*, *15*(5), 316–324. doi:10.1108/09544780310487712
- Dr. Benschop, A. (1996). Taylor and Scientific Management. Retrieved May 28, 2014, from http://www.sociosite.net/labor/Taylor/Taylor.html#Literatuur
- Endinet. (2014). Kwaliteits- en Capaciteitsdocument 2014.
- Enexis. (2014). Kwaliteits en Capaciteitsdocument Elektriciteit.
- EPA. (2008). Asset Management: A Best Practices Guide. US Environmental Protection Agency.
- Essent Netwerk B.V. (2007). Kwaliteits- en Capaciteitsdocument Elektriciteit.
- Gavronski, I., Ferrer, G., & Paiva, E. L. (2008). ISO 14001 certification in Brazil: motivations and benefits. *Journal of Cleaner Production*, *16*(1), 87–94. doi:10.1016/j.jclepro.2006.11.002
- Gay, L. F., & Sinha, S. K. (2013). Resilience of civil infrastructure systems: literature review for improved asset management. *International Journal Critical Infrastructures*, *9*(4), 330–350.
- Gotzamani, K. D., & Tsiotras, G. D. (2002). The true motives behind ISO 9000 certification: Their effect on the overall certification benefits and long term contribution towards TQM. *International Journal of Quality & Reliability Management*, 19(2), 151–169. doi:10.1108/02656710210413499
- GTS. (2013). Kwaliteits- en Capaciteitsdocument 2013 (pp. 1–78).
- Hodkiewicz, M. (2014). Asset Management quo vadis (where are you going)? *International Journal of Strategic Engineeing Asset Management*.

- Hortensius, D. (2012). Nieuwe structuur ISO-managementsysteemnormen is een feit. *KAM Nieuwsbrief*, 6–8.
- IAM. (2008). PAS 55-1:2008 Asset Management Part 1.
- ISO. (n.d.). What are the benefits of ISO International Standards. Retrieved May 28, 2014, from http://www.iso.org/iso/home/about.htm
- ISO. (2014a). ISO 55000: Asset Management Overview, principles and terminology.
- ISO. (2014b). ISO 55001: Asset management Management systems Requirements. ISO.
- ISO. (2014c). ISO 55002: Asset management Management systems Guidelines for the application of ISO 55001.
- Jones, R., Arndt, G., & Kustin, R. (1997). ISO 9000 among Australian companies: impact of time and reasons for seeking certification on perceptions of benefits received. *International Journal of Quality & Reliability Management*, 14(7), 650–660. doi:10.1108/02656719710173258
- Komonen, K. (2012). Asset Management: The State of the Art in Europe from a Life Cycle Perspective. (T. van der Lei, P. Herder, & Y. Wijnia, Eds.). Springer.
- Komonen, K., Kortelainen, H., & Räikkönen, M. (2012). Corporate Asset Management for Industrial Companies: An Integrated Business-Driven Approach. In *Asset Management* (pp. 47 63). Dordrecht: Springer Netherlands. doi:10.1007/978-94-007-2724-3
- Kostic, T. (2003). Asset management in electrical utilities: how many facets it actually has. 2003 IEEE Power Engineering Society General Meeting (IEEE Cat. No.03CH37491), 275–281. doi:10.1109/PES.2003.1267182
- Leung, H. K. N., Chan, K. C. C., & Lee, T. Y. (1999). Costs and benefits of ISO 9000 series: a practical study. *International Journal of Quality and Reliability Management*, 16(7), 675–690.
- Liander. (2013). Kwaliteits- en Capaciteitsdocument Gas 2013.
- Lloyd's Register Quality Assurance. (1999). Setting standards for better business.
- Mallak, L. A., Bringelson, L. S., & Lyth, D. M. (1998). A cultural study of ISO 9000 certification. *International Journal of Quality & Reliability Management*, 14(4), 328–348.
- Moatazed-Keani, R., & Ghanbari-Parsa Sechi, A. R. (1999). ISO 9000 standards: perceptions and experiences in the UK construction industry. *Construction Management and Economics*, 17(1), 107–119. doi:10.1080/014461999371871

- Morrow, D., & Rondinelli, D. (2002). Adopting Corporate Environmental Management Systems: Motivations and Results of ISO 14001 and EMAS Certification. *European Management Journal*, 20(2), 159–171.
- Morton, K. (1999). Asset management in the electricity supply industry. *Power Engineering Journal*, (October), 233–240.
- NAMS. (2011). International infrastructure Management Manual CH1&2. In *IIMM*. NAMS Limited.
- NEN. (2009). NTA 8120:2009.
- Netbeheer Nederland. (2011). Net voor de toekomst.
- Richard, P. J., Devinney, T. M., Yip, G. S., & Johnson, G. (2008). Measuring Organizational Performance as a Dependent Variable: Towards Methodological Best Practice.
- Rijksoverheid. Elektriciteitswet 1998 (1998).
- Rusjan, B., & Alic, M. (2010). Capitalising on ISO 9001 benefits for strategic results. *International Journal of Quality & Reliability Management*, 27(7), 756–778. doi:10.1108/02656711011062372
- Saker, T. (2008). Asset Management: BSI PAS-55 Overview Globally Emerging Perspectives & Challenges. *UMS Group & Asset Management Council*. UMS group & Asset Management council.
- Schipper, J., & Dik, L. (2013). The business case for PAS55. *The IAM Magazine: Assets*, (February), 19–21.
- Schylander, E., & Martinuzzi, A. (2007). ISO 14001 Experiences, Effects and Future Challenges: a National Study in Austria, *16*(July 2006), 133–147.
- Seddon, J. (1997). Ten arguments against ISO 9000. *Managing Service Quality*, 7(4), 162–168. doi:10.1108/09604529710172962
- Senapati, N. R. (2004). Six Sigma: myths and realities. *International Journal of Quality & Reliability Management*, 21(6), 683–690. doi:10.1108/02656710410542070
- Sharma, D. S. (2005). The association between ISO 9000 certification and financial performance. *The International Journal of Accounting*, 40(2), 151–172. doi:10.1016/j.intacc.2005.01.011
- Stedin. (2012). Jaarverslag 2012.
- Stevenson, T. H., & Barnes, F. C. (2000). Fourteen Years of ISO 9000: Impact, Criticisms, Costs, and Benefits. *Business Horizons*, (May-June).
- Summers Raines, S. (2002). Implementing ISO 14001 An International Survey Assessing the Benefits of Certification. *Int. Journal of Corporate Sustainability*, 9(4).

- Sun, H. (2000). Total quality management, ISO 9000 certification and performance improvement. *International Journal of Quality & Reliability Management*, 17(2), 168–179.
- Tassey, G. (2000). Standardization in technology-based markets. *Research Policy*, 29(4-5), 587–602.
- TenneT. (2013). Integrated Annual Report.
- Terziovski, M., Samson, D., & Dow, D. (1997). The business value of quality management systems certification Evidence from Australia and New Zealand. *Journal of Operations Management*, 15, 1–18.
- Tsekouras, K., Dimara, E., & Skuras, D. (2002). Adoption of a quality assurance scheme and its effect on firm performance: A study of Greek firms implementing ISO 9000. *Total Quality Management*, 13(6), 827–841. doi:10.1080/0954412022000010163
- UMS Group. (2007). Point of View on Asset Management.
- Van den Honert, A. F., Schoeman, J. S., & Vlok, P. J. (2013). Correlating the content and context of PAS 55 with the ISO 55000 series. *South African Journal of Industrial Engineering*, 24(2), 24–32.
- Vanier, D. J. (2001). Why industry needs asset management tools. *Journal of Computing in Civil Engineering*, 15(1), 35–43.
- Volker, L., Lei, T. Van Der, Boomen, M. Van Den, Der, J. Van, Wessels, P., Ligtvoet, A., & Herder, P. (2012). Continued Learning in Asset Management for the Dutch Transport Network. In *Third International Engineering Systems Symposium*.
- Volker, L., Lei, T. Van Der, & Ligtvoet, A. (2011). Developing a maturity model for infrastructural asset management systems.
- Way, P. J. (2013). IMPLICATIONS OF ISO 55000 STANDARDS ON INFRASTRUCTURE ASSET MANAGEMENT IN AUSTRALIA, (November).
- Wholey, J. S., Hatry, H. P., & Newcomer, K. E. (Eds.). (2010). *Handbook of Practical Program Evaluation*. Jossey-Bass.
- Wijnia, Y. C., & Herder, P. M. (2010). The state of asset management in the Netherlands.
- Wijnia, Y. C., Korn, M. S., Jager, S. Y. De, & Herder, P. M. (2006). Long term optimization of asset replacement in enery infrastructures. In *IEEE Conference on Systems, Man, and Cybernetics* (pp. 2615–2622).
- Withers, B. E., & Ebrahimpour, M. (1996). An examination of ISO 9000 registration practices of American, German and Japanese firms operating in the USA. *International Journal of Quality & Reliability Management*, 13(7), 8–22. doi:10.1108/02656719610128538

- Withers, B. E., & Ebrahimpour, M. (1999). Impacts of ISO 9000 registration on European firms: a case analysis. *MCB Univerity Press; Integrated Manufacturing Systems*, 12/2, 139–151.
- Zaramdini, W. (2007). An empirical study of the motives and benefits of ISO 9000 certification: the UAE experience. *International Journal of Quality & Reliability Management*, 24(5), 472–491. doi:10.1108/02656710710748358
- Zeng, S. X., Tian, P., & Tam, C. M. (2007). Overcoming barriers to sustainable implementation of the ISO 9001 system. *Managerial Auditing Journal*, 22(3), 244–254. doi:10.1108/02686900710733125

Annex A: An Example of a Risk Matrix

Pote	ntiële g	evolge	n					Po	tentië	ele ka	ns or	incid	dent i	net g	evolç	gen
								Vrijwel onmogelijk	Onwaar- schijnlijk	Mogelijk	Waar- schijnlijk	Geregeld	Jaarlijks	Maandelijks	Dagelijks	Permane
Categorie	Kwaliteit van Jevering	KLantenservice	Ima	ego	Financieel	Veiligheid	Duurzaamheid	Nooit eerder van gehoord in industrie	Wel eens van gehoord in industrie	Meerdere malen binnen industrie	Wel eens gebeurd binnen Liander	Meerdere malen gebeurd binnen Liander	Eén tot enkele malen per jaar binnen Liander	Eén tot enkele malen per maand binnen Liander	Eén tot enkele malen per dag binnen Liander	Eén toi enkele malen p dag binn regio va Liande
			Media	Politiek				<0,0001/jr	≥0,0001/jr	≥0,001/jr	≥0,01/jr	≥0,1/jr	≥1/jr	≥10/jr	≥100/jr	≥1000/
tampzalig	>10.000.000 vbm		International media- aandacht of meer dan één maand nationaal	Structureel conflict	Schade groter dan 10M euro	meerder doden	Schade groter dan IOM euro	M	М	н	н	ZH	ZH	ZH	ZH	Zŀ
Emstig	1.000.000 tot 10.000.000 vbm	Landelijke klanten ontevreden	Meer dan één week nationale bericht- geving	Incidenteel conflict	Schade van 1M tot 10M euro	Ongevallen met dodelijke afloop of zeer ernstig letsel	Schade van IM tot 10M euro	L	L	М	М	н	Н	ZH	ZH	ZI
Hevig	1.00.000 tat 1.000.000 vbm	Regionale klanten ontevreden	Landelijk artikel, week regionaal	Opeen- stapeling problemen	Schade van 100K tot 1M euro	Ongevallen met ernstig letsel met verzuim	Schade van 100K tot 1M euro	N	N	L	L	М	М	н	H	ZI
Matig	10.000 tot 1.00.000 vbm	Lokaal klanten ontevreden	Regionaal artikel	Incidenteel probleem	Schade van 10K tot 100K euro	Ongevallen met letsel met verzuim	Schade van 10K tot 100K euro	N	N	N	N	L	L	М	М	Н
Klein	< 10.000 vbm	20	Lokaal nieuws- bericht		Schade kleiner dan 10.000 euro	Bijna ongevallen, ongevallen met gering letsel/ EHBO zonder verzuim	Schade kleiner dan 10.000 euro	N	N	N	N	N	N	L	L	M

Figure 32: The Liander Risk Matrix for Asset Management. Risk impact is determined based on the chance of happening and its effect on the company values (Liander, 2013).

Annex B: Impact of Management Systems Literature

Paper	Research objective	Methodology	Categories of impact factors
(Boulter & Bendell, 2002) – How can ISO 9000 help companies achieve excellence? What companies think	Provide an empirical profile of company's own view on the value of ISO 9000 on the path to excellence of small businesses.	Detailed survey with 1000 respondents;Face-to-face interviews to verify results.	- Changes in the organization as a result of the implementation.
(Carlsson & Carlsson, 1996) - Experiences of implementing ISO 9000 in Swedish industry	Highlight different aspects of the change currently taking place in many companies to implement the quality system ISO 9000.	 Open-ended telephone interviews; Questionnaire to 214 companies; Longitudinal implementation study at 2 companies; 5-point Likert scale. 	 Reasons for implementing; Factors for successful implementation; Difficulties; Positive and negative effects.
(Chow-Chua et al., 2003a) – Does ISO 9000 certification improve business performance?	Investigate impact of ISO 9000 certification business performance of Singapore based companies.	Literature review;Survey using 5 point Likert scale;Examining annual reports;Interviews.	Motivations;Benefits; andChallenges.
(Douglas et al., 2003) – The case for ISO 9000	Summarizes arguments for and against the ISO 9000 standard and examines the perceived advantages/disadvantages of implementation.	 Literature study; Survey with quality managers, with yes/no questions and statements using a 5-point Likert scale. 	Reasons for seeking certification;Perceived benefits;Disappointments.
(Gavronski et al., 2008) – ISO 14001 certification in Brazil: Motivations and benefits	Analyzes relationship between corporate motivations and effects and benefits associated with ISO 14001 implementation in companies in Brazil.	 Questionnaire based on concepts identified in the literature; Questionnaire sent to chemical, mechanical and electronics industry; 	Effects on operational changes;Financial impacts;Relationship with business and societal stakeholders.
(Gotzamani & Tsiotras, 2002) – The true motives behind ISO 9000 certification: Their effect on the overall certification benefits and long term contribution towards TQM	Empirical research on the effect that an organization's true motives towards ISO 9000 certification may have on its future effectiveness and value to the certified companies.	Literature review to retrieve motives and benefits;Survey (84 respondents) with a 6 point Likert scale.	 Motives to implement ISO 9000; Performance improvements; Internal and external benefits from certification.

Paper	Research objective	Methodology	Categories of impact factors
(Mallak et al., 1998) – A cultural study of ISO 9000 certification	Investigate which cultural values and factors are important for successful implementation of ISO 9001.	Exploratory study;Survey (85 respondents);7-point Likert Scale.	- Critical cultural factors for a successful implementation.
(Moatazed-Keani & Ghanbari-Parsa Sechi, 1999) – ISO 9000 standards: perceptions and experiences in the UK construction industry	Research on implementation of ISO 9000 in UK construction industry based on the experiences and perceptions of quality managers.	 Initial review of the literature; In-depth case study interviews with quality assurance managers. 	Reasons for adopting ISO 9000;Impact of certification;Negative effects of certification.
(Morrow & Rondinelli, 2002) - Adopting Corporate Environmental Management Systems: Motivations and Results of ISO 14001 and EMAS Certification	Examines why small- and medium- sized domestic German firms adopt and certify an EMS and the results they obtain from doing so.	 Comparison of existing literature with in-depth case studies at 5 firms; Case study in specific sector. 	- Motivations; - Results and impacts.
(Schylander & Martinuzzi, 2007) – ISO 14001: Experiences, Effects and Future Challenges: A National Study in Austria	Explores the experiences and effects on Austrian organizations working with ISO 14001 and discussing future challenges.	Literature review;Questionnaire with environnemental managers	Motives;Expectations;Effects; andChallenges of ISO 14001.
(Summers Raines, 2002) Implementing ISO 14001—An International Survey Assessing the Benefits of Certification	Examines the motivation to pursue ISO 14001 certification for companies in developed and developing countries.	- Survey	- Costs; - Benefits; and - Motivations for ISO certification.
(Sun, 2000) – Total quality management, ISO 9000 certification and performance improvement.	This research aims to investigate the relations between TQM, ISO 9000 certification and performance.	Literature review;Survey (363 respondents).	- Performance effects of ISO 9000.
(Terziovski et al., 1997) – Business value of quality management systems certification, Evidence from Australia and New Zealand	Tests the strength of the relationship between ISO 9000 certification and organizational performance in the presence and absence of a total quality management environment.	 Literature review on company motives for adopting ISO 9000 certification and business value of ISO 9000 certification; Questionnaire. 	- Motives for adopting ISO 9000; - Effects on business values.

Paper	Research objective	Methodology	Categories of impact factors
(Withers & Ebrahimpour, 1996) – An	(Withers & Ebrahimpour, 1996) – An Compare the implications of		- Operational issues;
examination of ISO 9000 registration	registration with ISO 9000 within	- In-depth site interviews at 5 firms;	- Cost and level of effort needed to
practices of American, German and	groups of organizations.	- Survey instrument;	achieve registration;
Japanese firms operating in the USA		- Comparison of basic information.	- Reasons for pursuing registration.
(Withers & Ebrahimpour, 1999) -	Reports on the ISO 9000 experiences	- In-depth site interviews;	- Obstacles during implementation;
Impacts of ISO 9000 registration on	of 11 European firms.	- Questionnaire with 6-point Likert	- Impact of certification on
European firms: a case analysis		scale, tested for clarity and	operational factors; and
		relevance by quality experts;	- Resource requiring elements.
		-	
(Zaramdini, 2007) - An empirical	Analyze the different aspects of the	- Literature review;	- Motives for seeking certification;
study of the motives and benefits of	of the motives and benefits of motives and benefits of certified ISO - Survey with 5 point Likert scale;		- Benefits of certification.
ISO 9000 certification: the UAE	9001: 2000 companies in the United	- Validity check with quality experts.	
experience	Arab Emirates (UAE).		

Annex C: Impact Factors Retrieved from Literature

Motivations

Reference	Initial motivations for implementing or certifying	g a management system				
(Zaramdini, 2007)	Motivated by internal benefits of	Motivated by external forces (market) to get				
(certification:	certified:				
	Top management decision	Use as promotional or marketing tool				
	Improving service quality	Maintaining/increasing market share Demand or pressure from customers				
	Improving processes and procedures					
	Improving efficiency	Competitive advantage				
	Reduction of incidents, rejections and	Requisite to compete in the sector				
	complaints	Entry into new market				
	As a basis for internal cost reduction	Be role model for suppliers				
	Improving communication within	Improving public image				
	organization	Requested by government				
	Improving relationships between employees					
	and management					
/II	D () () () () ()					
(Lloyd's Register	Reasons for deciding to obtain certification:					
Quality Assurance,	To stay in business/To be considered for tenders					
1999)	To anticipate customer requirements in the future					
	To help improve customer service To maintain/increase market share					
	To maintain/increase market share To improve company efficiency/wastage					
	To provide a head start in international markets					
	To bring together various QMS systems in the cor	mnany				
	Marketing benefits					
(Rusjan & Alic, 2010)	Customer: Demands of the external environment (customers), customer benefits and related					
(Nasjan & Anc, 2010)	motives leading to a company's better financial					
	Internal: Improved organization, control and eff					
	Learning and Development: Improved employee morale, personal accountability for job					
	performance, better understanding of employee role in total process, improved internal					
	communication, internal improvement of the or					
		insurance costs, improve financial performance				
	and thus efficiency, decreasing costs.	, , ,				
(Carlsson & Carlsson,	Reasons for implementing ISO 9000:	<u>-</u>				
1996)	A step towards total quality	Group/management directive				
	International or domestic market customer	Reducing amount of scrap				
	demands	Reducing quality deficiency costs				
	Competition	Increased rapidity				
	Create better internal routines and	Organizational reasons				
	procedures	EU-directive/The products liability act/Public				
	Product/service quality	authority directive/Legal requirement				
	Development tool for the operation					
	Profitability					
(Beattie & Sohal,	<u>Drivers for certification:</u>					
1999)	Continuous improvement					
	Competitive edge					
	Overseas Requirement					
	Customer pressure private					
	Customer pressure government					
(Jones, Arndt, &	Reasons for seeking quality certification:					
Kustin, 1997)	Requirement of major customers					
	Desire not to be locked out of future tenders or n					
	Realization that it is becoming a requirement of c	loing business				
	Useful marketing or public relations tool					
	Desire to improve the company's internal process					
(NA	Desire to enhance the overall competitive perform	mance of the company				
(Moatazed-Keani &	Reasons for adoption of ISO 9000:					
Ghanbari-Parsa	Customer requirement					

Sechi, 1999)	Improving quality of management					
	Improving quality of Services					
	Improving customer satisfaction					
	Improving productivity					
	Marketing advantage					
	Maintaining competitive edge					
	Enhancing sales/profits					
(Buttle, 1997)	Reasons for pursuing ISO 9000 certification:					
	Anticipated demand from future customers for ISO 9000					
	Increase consistency of operations Maintain /improve market share					
	Maintain/improve market share					
	Improve service quality Customer pressure					
	Desire to use ISO as a promotional tool					
	Make operations more efficient					
	Improve product/service quality					
	Provide proof of commitment to TQM					
	Achieve cost reductions					
(Douglas et al., 2003)	Reasons for implementing ISO 9000:					
, ,	The help improve customer service					
	Anticipating future customer requiremen	ts				
	To maintain/increase market share					
	To be considered for tenders					
	To improve organizational efficiency					
	To provide a head start in international m	narkets				
	To bring together various QM systems wi	thin the organization				
	Marketing benefits					
(Gotzamani &	<u>Certification motives:</u>					
Tsiotras, 2002)	<u>External</u> <u>pressure/competitive</u>	Quality improvement: Quality strategy:				
	advantage:					
	Future customer demand	Quality improvement of final Part of overall				
		products/services quality policy				
	Competitive advantage	Quality improvement of Introduction to internal processes TQM				
	Entry to foreign markets	Improvement of internal				
	Littly to foreign markets	communication				
	Certification of competitors	Improvement of external				
	· ·	communication				
	Satisfaction of customer demand					
(Morrow &	Motivations for adopting an EMS in Germ	an Energy and Gas industry:				
Rondinelli, 2002)	Achieve continuous improvement					
	environmental performance	Detect and minimize environmental and				
	Identify weaknesses	liability risks				
	Identify potential uses of energy source					
	Motivate employees	Achieve cost savings				
	Improve image	Respond to customer and other pressure				
	Increase legal certainty	group demand				
	Improve internal organization	Enhance process and product environmental				
(Cabular des	Expectation and remained have fits 1996	innovation				
(Schylander & Martinuzzi, 2007)	Expectation and perceived benefits of ISC					
ividi tilluzzi, 2007)	Ensure legal compliance Systemization of environmental activities	Identify cost reduction potentials Improve relation with authorities				
	Improve the environmental performance					
	Risk minimization	production				
	Improve public image	Improve employee motivation				
		Get new customers				
(Summers Raines,	Motivations for Certification with ISO 140	<u> </u>				
2002)	Potential economic savings					
	Requirements from parent company					
	Desire to display environmental leadersh	p/be a good neighbor				
	Green marketing benefits					
	Incentives and/or pressure from governm	nent regulators				

Desire to receive regulatory relief
Requirements of trading partners
Desire to increase exports
Desire to reduce liabilities / Reduce insurance premiums

Challenges

Reference	Challenges/barriers/obstacles during implement	tation of management system				
		tation of management system				
(Schylander &	<u>Difficulties in the implementation of ISO 14001:</u>					
Martinuzzi, 2007)	Environmental policy	Document control				
	Environmental aspects	Operational control				
	Legal and other requirements	Emergency preparedness and response				
	Objectives and targets	Monitoring and measurement				
	Environmental management program	Nonconformance, corrective and preventive				
	Structure and responsibility	action				
	Training, awareness and competence	Records				
	Communication	Audit				
	Documentation	Management review				
(Chow-Chua, Goh, &	Barriers to ISO 9000 implementation:					
Wan, 2003b)	Failure to provide adequate controls over documents and the data in them					
	Failure to define responsibility and authority for	r personnel				
	Inadequate training					
	Gaining management and employee commitment					
	Problems with interpretation of standards					
	Problems with assessors and consultants					
	Problems with documentation					
	Common post-implementation problems:					
	A cumbersome unworkable document control process					
	Failure to carry out management reviews of the					
	Audit programs failing to provide feedback to	management on compliance with policies and				
	procedures					
(Carlsson & Carlsson,	Difficulties experienced in implementing ISO 9000	<u>0:</u>				
1996)	Time and resource consuming					
	Difficulties in interpreting standard					
	Cumbersome and bureaucratic documentation					
	Initial difficulties in making the quality system un					
	Difficulties in choosing a suitable level for docum	entation				
	Difficulties in setting relevant quality goals					
	Difficulties in communicating the message					
	Difficulties in securing employee commitment					
	De accountant lack the knowledge of our line of k	ousiness				
	Unclear guidelines from the certifying body					
(Withers &	Obstacles encountered during ISO 9000 certificat					
Ebrahimpour, 1999)	Implementation time	Top management involvement				
	Inadequate ISO training	Internal resistance				
	Difficulty interpreting standards	Corporate culture				
	Over documentation	Poor document control				
	Poor existing documentation	Middle management involvement				
	System changes					
(Beattie & Sohal,	Challenges associated with gaining ISO 9000 certi	fication:				
1999)	Cost and time problems					
	Gaining management and employee commitmen	t				
	Interpretation of standards					
	Problems with assessors and consultants					
	Problems with documentation					
(Zeng, Tian, & Tam,	Barriers to effective implementing ISO 9001 stand	<u>dard:</u>				
2007)	Short sighted goal for getting certified					
	Over-expectation on ISO 9001 Standard					
	Mandatory requirement – no full commitment					
	Following other in certification					
	Lack of necessary guidance for certification					

(UMS Group, 2007)	Common barriers in implementing AM:
	Silo thinking
	Short term thinking
	Conflicting performance measures
	Business focus
	Risk management
	Too much data

Positive effects

Reference	Positive effect of implementing a management system					
(Tsekouras, Dimara,	Effects of adopting ISO 9000 on firm performance					
& Skuras, 2002)	Financial:	Non-financial:				
,	Firm Growth	Improved organizational efficiency				
	Profitability	Enhanced management practices				
	Capital structure	Increased consistency of operations				
	Increased market share	Increased customer satisfaction				
	Save costs	Improved customer service				
		Improved marketing position				
(Casadesús, Giménez,	Benefits companies obtain from implementing th					
& Heras, 2001)						
Q 110103, 2001)	increase in company quality awareness;					
	increase in product quality awareness;					
	improvement in management;					
	improvement of customer relations;					
	improvements in the products and services offe	arod:				
	improved relationships within the organization;					
	greater customer satisfaction;					
	increased respect from competitors;					
	an important marketing tool which helps market relations;					
	increases the chances of winning new contracts; decreases the number of customer audits;					
	helps penetration of international markets considerably.					
	Internal:					
	improved awareness of the importance of quality;					
		• •				
	improved awareness of the problems of the company;					
	improvement in product quality; improvement of the definition and standardization of work procedures;					
	improvement in the definition of the responsibi	•				
		intes and obligations of the workers,				
	increased company confidence in their quality; greater commitment to work;					
		ed guidelines reducing improvisation;				
	improved job satisfaction;					
	improved job satisfaction, improved communication between managemen	at and ampleyees				
		it and employees.				
	External: increased customer satisfaction;					
	improvement in product quality and market cor	motitivonoss				
	satisfaction of customers' requirements;	ilpetitiveness,				
	better response to customers' requirements;					
	penetration of new markets;					
	improved customer relations;					
	improved customer relations, improvement in customer services;					
	reduction of customer audits;					
	the increased customer satisfaction;					
	the drop in the number of complaints;					
	the rise in repeat purchasing.					
(Lloyd's Register		Panafits from installing a OMC.				
	Benefits from achieving certification:	Benefits from installing a QMS:				
Quality Assurance,	Able to stay in business/not excluded from	Improved management control/				
1999)	tenders;	organization/planning				
	Expand/improve market share;	Improved efficiency/productivity				
	Public relations/ advertising/ marketing	Consistency across the organizations				
	Improve efficiency/less wastage	Reduced waste				

	Increased customer satisfaction Greater discipline/order Helped in international markets Reduction in customer audits More quality awareness/ impro Objective external appraisal h	s oved quality	·	omer service retention/motivation oblems/improving awareness of
(Rusjan & Alic, 2010)	Benefits of implementing a QMS: Customer perspective: Improved supplier selection; Improvement in service quality; Fewer non-conformities of delivered service and thus fewer complaints; Improved communication and relationships with customer and supplier; Improved customer satisfaction; Improved image of the company; Retention of existing customer and acquisition of new ones; Increased volume of sales.			ective: ty of the procedures; in quality planning, control and ag; eesses; scrap decrease and an n handling them; xternal auditing and need for rol; tivity; in process efficiency;
	Learning & development persponder locreased qualification of emplimplementation of work tasks; Increased transfer and dissipation knowledge among employees; Improved communication and among employees; Commitment to a quality and morale; Continuous improvement management; Improved work motivation and the employees; Innovation and building of a continuous advantage;	d relationship d better work in quality satisfaction of	wastage, custo of processes, and thus opera	ts – decrease in scrap, material omer complaints, improvement effectiveness, service quality ational costs; me – improved services; itability;
(Leung, Chan, & Lee, 1999)	Benefits from ISO 9000 system: To staff: Improved team spirit Clearer working procedures Less conflicts Lower staff turnover rate More suggestions from staff	subcontractors Reduced opera Increased production	ry team iency ity ontrol of s ational costs quantity of	To business: Increased sales with existing customers Attracted more new customers Received less complaints Increased profits Customers exercised less control on your process
(Carlsson & Carlsson, 1996)	Reported measurable results of I	•		

(Stevenson & Barnes, 2000)	More efficient routines Improved internal quality Improved total quality More customers Improved delivery precision Increased product quality More efficient manufacturing Top ten anticipated benefits of ISO certification Improvement in documentation Improvement in operating standards Improvement in quality awareness Ability to sustain market share Improvement in perception of product quality Ability to increase market share Reduction in cases of nonconformity Improvement in customer satisfaction Improvement in competitor advantage Reduction in quality audits	Improved p Reduced lea New marke Increased p Reduced gu	nd times ts	
(Casadesús & Karapetrovic, 2005)	Benefits of ISO 9000 implementation: Operational results – Decreasing non- conformities Financial results – market share	Decreasing lo Increasing in Decreasing n	ventory turnover conconformities delivery date	
		Return on investment Market share Sales per employee		
	Customers - satisfaction	Loyalty/repeated purchase Satisfaction Decreasing of the complaints		
	Workers - involvement	Suggestion systems Health and security at work Team participation Employee absenteeism Work satisfaction		
(Withers &	Impacts of ISO 9000 registration on operations a	nd performan	се	
Ebrahimpour, 1999)	Internal communication (+)	Productivity	• •	
	External communication (+)	Cycle time (
	Employee relations (+) Documentation costs (-)	Competitive Product qua		
	Inspection time (+/-)	Service qua		
	Process design (+)	Public imag		
	Operating costs (+)	Market shar	re (+)	
(Beattie & Sohal,	Effects of certification:		benefits from ISO 9000:	
1999)	Improved contracts	Employee s		
	Improved staff morale Customer satisfaction	Customer se Employee n		
	Improved procedures	Improved p		
	Production improved	Scrap/rewo	rk	
			mmunication	
		Internal con Culture cha	nmunication nge	
(Jones et al., 1997)	Internal benefits:	23	0-	
	Great standardization of operational procedures			
	Fewer mistakes and less defective work			
	Fewer customer complaints More business			
	INICI C DUSITICSS			

	Lower operating costs			
(Moatazed-Keani & Ghanbari-Parsa Sechi, 1999)	Impact of ISO certification: Retaining business Less failure of work Better management Increased customer satisfaction Less wastage on site Less delay in project completion Enhanced sales Gaining entry into new markets			
(Buttle, 1997)	Benefits of ISO 9000 certification Profitability: Productivity gains Improving profitability Cost reduction Reducing waste Improving staff motivation	Process improve Facilitating e procedural pro	limination of blems wareness of blems ment control in of new staff omer service iency	Marketing: Gaining new customers Keeping existing customers Using standard as a promotional tool Improving market share Increasing growth in sales Increasing customer satisfaction
(Zeng et al., 2007)	Improvements after gaining ISO 9001 certification: Internal operations Customers relations Marketing share Subcontractor relations			
(Sharma, 2005)	Internal improvement theory: External improvement theory: Increase customer base Increased productivity and efficiency Increase market share Increase sales			
(Douglas et al., 2003)	What are the perceived benefits Increased market opportunities Reduced costs Improved image towards custo Stronger reputation in t stakeholders Reduced waste (time and mate	mers he eyes of	Improved man	mer satisfaction agement control margins, sales per employee,

(Gotzamani &	Certification benefits factors:	
Tsiotras, 2002)	Internal/operational benefits: Improvement of internal organization and operation Development of quality culture Employee-management communication improvement Employee communication improvement Development of teamwork Increase in employee satisfaction Increase in employee participation Customer communication improvement	Quality improvement: Less rework and defectives Improvement of final product quality Improvement of suppliers' performance Increased customer satisfaction Less complaints Less returns External/competitive benefits: Improved competitive position Sales increase Profits increase Easier penetration in new markets Reduction of absences
	Productivity improvement	
(Morrow &	Benefits German companies gained from particip	nating in ENAC.
Rondinelli, 2002)	Better organization and documentation Increased legal certainty Improved image Greater employee motivation Reduced resource use Enhanced plant safety Opportunity to set the example for suppliers Optimization of process flows	Improved cooperation with authorities Positive market effects Cost savings Competitive advantages/safeguard of the site More favorable insurance/loans Opportunity to use public funds for development purposes
(Schylander &	Expectation and perceived benefits of ISO 14001	
Martinuzzi, 2007)	Ensure legal compliance Systemization of environmental activities Improve the environmental performance Risk minimization Improve public image Identify cost reduction potentials Improve relation with authorities Technology improvement — cleaner production	Improve employee motivation Get new customers Environmental awareness of management and employees Increase life-cycle of products Reduction of waste, energy, raw material, transport, emissions and costs Improve soil and water conditions Increase recycling
(Summers Raines, 2002)	Benefits: Benefits to trade Benefits to profits Benefits to the environment Improved relation with regulator	

Negative effects

Negative effect of implementing a management system
Disappointments with certification:
Not retained/increased as much business as expected
Number of customer quality audits still conducted
Standard/consistency of assessors
High costs involved
Increased/complex paperwork
Number of questionnaires still have to be filled in
Some companies who required it are still using companies which don't have certification
Discontents with ISO 9000 implementation:

	Cost-related discontents during implementation:		
	Consultant fees		
	Certification audit fees		
	Equipment calibration fees		
	Purchase of additional equipment/facilities		
	Costs of establishing the documentation system		
	Costs of recruiting additional staff for implementing ISO 9000		
	Additional time spent by existing staff on setting up the ISO 9000 system		
	Cost-related discontents during maintenance:		
	Surveillance audit fees		
	Equipment calibration fees		
	Costs of maintaining the documentation system		
	Staff training		
	Additional time spent by staff on maintaining the ISO 9000 system		
	Discontents about benefits:		
	Improved team spirit	Increased sales with existing customers	
	Less staff conflicts	More new local customers	
	More suggestions	Increased profits	
	Reduced wastage of materials	Less customer complaints	
	Shorter delivery lead time	Less customer control	
	Increased efficiency	Enhanced communication with customers	
	Increased quantity of production		
	Reduced operational costs		
(Casadesús &	Negative points regarding ISO 9000 certification:		
Karapetrovic, 2005)	No recovery of costs of the ISO 9000 implementa	tion	
	No benefits from implied savings from less and ea		
	Increased logistics costs, nonconformities and lea		
(Moatazed-Keani &	Negative effect of ISO certification:		
Ghanbari-Parsa	More bureaucracy	Time consuming	
Sechi, 1999)	Added costs	Superficial and variable interpretation	
, ,	Lack of innovation		
	No improvement		
(Seddon 1997)	Ten arguments against ISO 9000		
(Seddon, 1997)	Ten arguments against ISO 9000:	which make things worse for their customers.	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways	which make things worse for their customers;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality;		
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption	which make things worse for their customers; that work is best controlled by specifying and	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures;	that work is best controlled by specifying and	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to	that work is best controlled by specifying and o cause sub-optimization of performance;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control	that work is best controlled by specifying and o cause sub-optimization of performance;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to The standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls;	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to The standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-supplied.	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations;	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-supparts an intervention, ISO 9000 has not encouraged	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations;	
(Seddon, 1997)	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000:	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations;	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to The standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppersump As an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations;	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-supper As an intervention, ISO 9000 has not encouraged what's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations;	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-supper As an intervention, ISO 9000 has not encouraged what's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-supper As an intervention, ISO 9000 has not encouraged what's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, considered.	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppas an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, considered the standard with new and better were supparted to the standard	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consulted the subject of the standard with new and better we too high costs	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption in the standard with new and better works are interference of standard with new and better works. Criticisms of ISO 9000:	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, considered the costs of the costs o	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumer free control to the promotes and better works Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal postep backwards in the quest for TQM	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently.	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption of the standard with new and better was Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal prostep backwards in the quest for TQM Relies heavily on others	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Juliants and registration vays of working	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption of the standard with new and better was Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal proster backwards in the quest for TQM Relies heavily on others Effective only if accompanied by culture changes	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Juliants and registration vays of working	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption in the standard with new and better was Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal processes actions actio	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Juliants and registration vays of working	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption in the standard with new and better was Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal processes actions actions actions actions actions actions act	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Juliants and registration vays of working	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppersum	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Juliants and registration vays of working	
	ISO 9000 encourages organizations to act in ways Quality by inspection is not quality; ISO 9000 starts from the flawed presumption controlling procedures; The typical method of implementation is bound to the standard relies too much on people's and, in When people are subjected to external control those things which are affected by the controls; The standard promotes, encourages and explicitly ISO 9000 has discouraged managers from learning ISO 9000 has failed to foster good customer-suppass an intervention, ISO 9000 has not encouraged What's wrong with ISO 9000: Quality by inspection is not quality Heavy reliance on people Unnecessary paper works No recoupment of costs on time, training, consumption in the standard with new and better was Too high costs Criticisms of ISO 9000: Promotes actions which result in sub-optimal processes actions actions actions actions actions actions act	that work is best controlled by specifying and o cause sub-optimization of performance; particular, assessors' interpretations of quality; s, they will be inclined to pay attention only to y demands actions which cause sub-optimization; g about the theory of variation; olier relations; managers to think differently. Cultants and registration rays of working Deformance Extra volume to pay attention only to a	

Master of Science Thesis

	Standard/consistency of suppliers High costs involved Increased/complex paper work Number of questionnaires still have to complete Organizations still using supplier without ISO 9000	
(Stevenson & Barnes, 2000)	Criticisms to ISO 9000 Certification: Too costly (In time, in training, in consultants and the registration itself); A pursuit of quality certificates rather than a pursuit of quality; Too much paperwork; Interferes with new and better ways of operating; Costs range from 250.000\$ for smaller firms, to over 1m\$ for large firms and yearly maintenance costs can be as much a 70k\$.	
(Withers & Ebrahimpour, 1999)	Most costly element of ISO 9000: Document and data control Internal quality audits Quality system Training Contract review	Design control Corrective and preventive actions Process control Management responsibility Inspection and testing
(Biazzo & Bernardi, 2003)	Negative effects of ISO 9000: Bureaucratising the firm's operations because of Innovation and continuous improvement are not Applying the norms promotes stagnation.	

Critical success factors

Reference	Critical success factors for implementing a management system	
(Mallak et al., 1998)	Cultural values and factors:	
(Precision Highly organized Team oriented Decisive	Equity Assertive Human Resources
	Risk Averse Stability Results Co-operative	Workplace uncertainty Reflective Risk Taking Awareness of others Informal
(Saker, 2008)	Critical Success Factors for implementing PAS 55: Commitment of entire organization Workload of employees Cultural differences in the organization Uniformity of doing the job Scope of the system Changes of organization Availability of documents and registration	
(Rusjan & Alic, 2010)	Pre-conditions of QMS implementation leading to improved business performance: Management support: Coupling of motivation for introducing ISO 9001 with management support; Internal vs. external motivation: Internal motivation leads to greater impact on competitiveness and business performance; Link between QMS and strategic objectives: QMS contributes to company performance through implementation of a company's vision and mission and or strategic goals associated with the two.	
(Leung et al., 1999)	Factors determining the cost-benefit: The time taken to get certified Number of years since certification Reasons for certification	
(Carlsson & Carlsson, 1996)	Reported factors for the successful implementation of ISO 9000: Management commitment Involvement and commitment of all personnel concerned Work performed using mainly own resources Routines already in place used as a starting point Certification part of a focused quality strategy Internal audits performed in the course of the work	

	Recording present value not targeted value Work controlled by a central project group Working with the certifying body at an early stage Writing the manual first Importance of consultant	
(Moatazed-Keani &	Relative importance of ten selected items to quality in construction:	
Ghanbari-Parsa	Manual	Delivery of information
Sechi, 1999)	Staff	Internal audit
	Organization	External audit
	Confirmation of contract contents	Enlightenment and education
	Responsibilities and rights	Documentation

Positive effects of asset management claimed by AM institutes & Promoters

Reference	Intended positive effect of asset management	
(Schipper & Dik,	Benefits of implementing PAS 55 as a management system for a Electricity distribution company:	
2013)	Structured documentation	Lower interest rates
	Structured and transparent processes	Lower insurance premium
	Alignment between strategy, policy and plans	Improved negotiating position with regulator
	Improved transparency and control of	More credibility with ratings agencies
	workflow	Easier audits
	Better understanding of risks	More confidence at shareholder level
	More thorough budgeting prioritization	Improved reputation
(EPA, 2008)	Benefits of Asset Management:	
	Prolonging asset life and aiding in rehabilitate/re	pair/replacement decisions through efficient and
	focused operations and maintenance.	
	Meeting consumer demands with a focus on syst	em sustainability.
	Setting rates based on sound operational and final	ancial planning.
	Budgeting focused on activities critical to sustain	ed performance.
	Meeting service expectations and regulatory requ	uirements.
	Improving response to emergencies.	
	Improving security and safety of assets.	
(ISO, 2014c)	The benefits of asset management can include, b	ut are not limited to the following:
	Improved financial performance	
	Informed asset investment decisions	
	Managed risk	
	Improved services and outputs	
	Demonstrated social responsibility	
	Demonstrated compliance	
	Enhanced reputation	
	Improved organizational sustainability	
	Improved efficiency and effectiveness	
(NAMS, 2011)	The benefits of improved Asset Management:	
	Strong governance and accountability	
	More sustainable decisions	
	Enhanced customer service	
	Effective risk management	
	Improved financial efficiency	
(BSI Group, 2014)	An asset management system provides a struc	tured, best practice approach to managing the
	lifecycle of assets:	
	Reduced risks associated with ownership of as	sets – anything from unnecessary maintenance
	costs and inefficiency to accident prevention;	
	Improved quality assurance for customers/reg	ulators – where assets play a key role in the
	provision and quality of products and services;	, , , , , , , , , , , , , , , , , , , ,
		nfidence from the knowledge that a strategy is in
	place to ensure assets meet the necessary requir	
		demonstrating that the requirements of an
	internationally recognized asset management sys	stem are being met.

Annex D: A Filled In Interview Format

Basis informatie over organisati	e met betrekking tot AM
Organisatie	Dutch TSO/DSO
Functie	Risico manager – Ooit een keer een project gestart binnen risico en portfolio management, de spil binnen asset management. Zo is dat bij Sebastiaan blijven plakken en daaruit voort is de implementatie van een AMS gekomen.
AMS? Wanneer operationeel?	Ja. Zijn begonnen met het implementeren van een AMS in 2004. Dat begon met risico matrices maken, projecten in een portfolio plaatsen en constant aanpassen. Er is geen duidelijk moment wanneer zoiets operationeel is. Inmiddels is hij risico gedreven aan het investeren, zijn risico matrix constant aan het bijwerken.
Certificaat? Wanneer gekregen?	Management system wel verplicht door ACM. NTA of PAS 55 is niet verplicht, maar DSO/TSO heeft toen bewust niet een ISO 9000 gekozen, maar wel de NTA en daar was de ACM ook wel blij mee. Certificaten voor zowel PAS55 als NTA 8120 (is 1 audit) en ISO 9001 zijn in 2012 verkregen. DSO/TSO was wel 1 van de laatste binnen de sector om het certificaat te krijgen. NTA is meest specifiek en dus het moeilijkst om te halen.
Hoe ziet het eruit?	Vanaf 2004 ook de drie rollen van AO, AM en SP gaan scheiden. AO was altijd al een vaste rol in de directie staf, maar vooral AM en SP zaten onder 1 hoed. In 2006 zijn die ook gescheiden. In principe wel door de hele organisatie, maar dat is logisch gezien de core-business van DSO/TSO. De AO bepaalt het 'waarom', de AM de 'wat' en de SP de 'hoe'. DSO/TSO heeft zowel interne als externe SP's. De hele AM kolom is gecertificeerd, dat is ongeveer 2/3 van het hele bedrijf.
Gap analysis?	Toen DSO/TSO in 2004 begon met implementeren, beheerden ze alleen nog de netten met de hoogste spanning. Daar is in de tussentijd alles van 10kV en hoger bijgekomen. Organisatie gegroeid van paar 100 naar bijna 1000 man. UMS heeft de gap-analyse als 0-meting gedaan bij DSO/TSO begin 2011. Op een schaal van 1-5 stonden ze toen op 2.2/2.3. In 2004 gaf Sebastiaan zichzelf een 1.
Ervaring met andere management systemen?	Begonnen met AM. De organisatie is eerst NTA en PAS gecertificeerd, voor de AO en AM gedeelte. De interne SP bij DSO/TSO was al in 2006 ISO 9001 gecertificeerd, was een bottom-up initiatief.
AMS geïntegreerd met andere systemen?	Wel geïntegreerd met ISO 9001. Er is maar 1 MS, het DSO/TSO MS. Dat systeem voldoet aan 3 normen. Voor het inhoudelijk op elkaar aansluiten van de systemen is daarbij het belangrijkst.
Wat is kwaliteit en hoe wordt het gemeten?	7 bedrijfsdoelen. Veiligheid, kwaliteit van levering, financieel e.d. Waarvan de eerste twee het belangrijkst zijn. De eenheid hiervoor is de hoeveelheid verzuim als gevolg van een ongeluk op het werk. Publieke ongelukken worden niet echt gemeten voor het AMS.
Wat is performance en hoe wordt het gemeten?	Kwaliteit van levering: duur, frequentie en # klanten. De KPI's zijn verwerkt in de CAO. Netbeschikbaarheid van DSO/TSO is erg hoog en het is niet te zeggen of het AMS invloed heeft gehad op dat getal. Bij distributie bedrijven is dat makkelijker te zeggen, omdat hun spullen vaker stuk gaan.
Wat zijn risico's en hoe wordt het gemeten?	Het is een inschatting van wat je verwacht dat er gaat gebeuren. Vooraf aan risicobepaling gaat het identificeren van knelpunten. Daar hebben ze het meeste moeite mee. Als je de knelpunten niet hebt, heb je ook niets aan risico management. Risico's worden zoveel mogelijk gekwantificeerd, dmv faalstatistiek. Anders doe je het met kwalitatieve zaken. Het is moeilijk om te zeggen of het AMS hier een groot aandeel in heeft gehad.
	ementeren van een asset management systeem
Open vraag motivatie	Bij DSO/TSO was voor het feit dat andere netbeheerders, zowel in Engeland als in NL (Enexis en voorganger van Stedin) al bezig waren met AM een reden om daar ook mee te beginnen. Daarnaast werd het steeds belangrijker om meningen van buitenaf (de mondige burger, vertegenwoordigd door de regulator) mee te nemen in beslissingen. Hoe vroeger alle investeringen zomaar in de tarieven werden gestopt, wordt daar nu veel meer op gelet. Ze hadden een nieuwe competentie nodig, om de meningen van buitenaf mee te nemen. Investeerders zijn ook stakeholders van DSO/TSO en zij verwachten rendement. De beperkte bewegingsvrijheid (kan niet overal bouwen, milieuwetgeving, compliance, reputatie) vat dit samen.
Secundaire vragen:	 Was dit voor uw organisatie onderdeel van de motivatie? Zo ja, waarom was dit voor u belangrijk? Wat wilde u bereiken met het AMS? Zo nee, zou u zich kunnen voorstellen dat dit een motivatie kan zijn? Voor organisaties binnen/buiten uw sector?
- Kosten vermindering?	In theorie zit dit wel in het model gebakken. De asset manager krijgt de mogelijkheid

- Verhogen van performance/asset output?	om competitie in te brengen onder de service providers, omdat deze rollen gescheiden zijn. Dit ligt echter lastig in de sector. Beheer van de netten moet grotendeels intern geregeld zijn (80/20 intern/extern). Het was geen directe motivatie van DSO/TSO. Was geen motivatie van DSO/TSO. Is ook weinig verandering in gekomen. Kan zich wel voorstellen dat het systeem helpt om focus aan te brengen om intern uit te voeren wat men extern aan problemen tegenkomt en dat kan de per-formance verhogen. 'Er valt wel wet te helpt'. Scottich Bewer is een veerheeld.
- Marktaandeel vergroten?	wel wat te halen'. Scottish Power is een voorbeeld. Geen motivatie bij DSO/TSO, door sector structuur. Weinig ISO 55000 implementeerders zullen dit als motivatie hebben, omdat het toch vaak monopolisten zijn.
- Betere beheersing interne processen?	Absoluut, je brengt focus aan. Transparantie is zeker een motivatie geweest. Overigens is dat wel iets wat ze pas als laatst op orde kregen. Alle aspecten waren geïmplementeerd, maar transparantie was er nog niet echt. Zo'n MS gaat dan ook niet in je voordeel werken. Van boven tot beneden sluit het op elkaar aan.
- Top management beslissing?	De beslissing om AM in te voeren is wel een top management beslissing geweest. Certificering is vooral vanuit regulering opgedrongen. Het is niet top down aan de organisatie 'opgedrongen'.
- Verbeteren risico management?	Er was nog geen risico management voordat het AMS werd ingevoerd, dus dat ging gecombineerd. Het was een bijkomend voordeel om risico's op orde te krijgen. Dit was dus geen motivator. Wel was het feit dat andere partijen wel een risicomatrix hadden een reden om hier ook aan te beginnen.
- Voldoen aan regelgeving veiligheid en zekerheid?	Vooral voldoen aan regelgeving was een motivatie, ook in 2004. Veiligheid niets eens zo zeer. DSO/TSO moest een management systeem hebben. Daar hebben ze lange tijd niet aan voldaan. Er is een verschil hierin tussen Gas en Electriciteit. Vanuit de SodM ligt minder druk op gas netwerkbeheerders om de NTA te implementeren.
- Imago verbetering?	Imago verbetering heeft zeker een rol gespeeld voor DSO/TSO. Het is niet zo dat het 'doen van asset management' naar de buitenwereld duidelijk zou maken dat DSO/TSO haar zaken op orde heeft, maar het werkte meer in negatieve zin. Het feit dat DSO/TSO geen AMS systeem had, zorgde er o.a. voor dat het imago niet goed was. 'Er werd op de reputatie gelet.' Ze kwamen daarom snel uit bij asset management als tool om transparantie te verbeteren. Ze stonden meer in de spotlight of onder vuur.
Uitdagingen/obstakels tijdens h	
Open vraag	- Het werken met een risico matrix en de uitkomst daarna dusdanig serieus nemen dat
uitdagingen/obstakels	je er ook naar gaat handelen. Dat bleek een lange weg te zijn. Het maken en invullen van de matrix is zo gedaan, maar het naleven vergt een cultuurverandering. Eerst was het resource based handelingen uitvoeren en nu werd het ineens risico-gebaseerd
	handelen. Het heeft 8 jaar geduurd om echt buiten te zien gebeuren wat er binnen is besloten.
	besloten Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet
	besloten. - Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet gebeuren. Dit is ook een proces van 6 jaar geweest. Daarbij moet gezegd worden dat DSO/TSO een gelukkige uitzondering is. Dat komt omdat zij wel grote, maar ook weinig spullen hebben, waar RNB's meer spullen hebben.
Secundaire vragen:	besloten. - Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet gebeuren. Dit is ook een proces van 6 jaar geweest. Daarbij moet gezegd worden dat DSO/TSO een gelukkige uitzondering is. Dat komt omdat zij wel grote, maar ook weinig spullen hebben, waar RNB's meer spullen hebben. - Heeft u dit ervaren? - Zo ja, hoe kwam het tot uiting? Tijd, geld of moeite? Waar kwam dit door? Welke eigenschappen/ karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke onderdelen van de norm hebben hiertoe geleid?
Secundaire vragen: Informatie over huidige assets?	besloten. Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet gebeuren. Dit is ook een proces van 6 jaar geweest. Daarbij moet gezegd worden dat DSO/TSO een gelukkige uitzondering is. Dat komt omdat zij wel grote, maar ook weinig spullen hebben, waar RNB's meer spullen hebben. Heeft u dit ervaren? Zo ja, hoe kwam het tot uiting? Tijd, geld of moeite? Waar kwam dit door? Welke eigenschappen/ karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke onderdelen van de norm hebben hiertoe geleid? Zo nee, kunt u zich hier iets bij voorstellen? Of past dit niet in het rijtje? Ja door de vele fusies is 50% van de informatie verdwenen. DSO/TSO is nu goed op track. Statische data is bijna compleet, maar dit is een zeker een langdurig proces
Informatie over huidige assets? AM documentatie problemen?	besloten. Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet gebeuren. Dit is ook een proces van 6 jaar geweest. Daarbij moet gezegd worden dat DSO/TSO een gelukkige uitzondering is. Dat komt omdat zij wel grote, maar ook weinig spullen hebben, waar RNB's meer spullen hebben. Heeft u dit ervaren? Zo ja, hoe kwam het tot uiting? Tijd, geld of moeite? Waar kwam dit door? Welke eigenschappen/ karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke onderdelen van de norm hebben hiertoe geleid? Zo nee, kunt u zich hier iets bij voorstellen? Of past dit niet in het rijtje? Ja door de vele fusies is 50% van de informatie verdwenen. DSO/TSO is nu goed op track. Statische data is bijna compleet, maar dit is een zeker een langdurig proces geweest. De policy voor asset management moest gehaald worden uit een grote wolk van beleidsdocumenten met verschillende thema's. Niet alles was daarvan relevant voor AM, dus het was even zoeken naar de juiste stukken informatie. Daaruit zijn ook de doelstellingen gedestilleerd. Het filteren van juiste informatie was daarom een uitdaging.
Informatie over huidige assets?	besloten. Ontbrekende informatie van de current asset base. De SP, die bijna dagelijks naast de assets staat weet vaak wel wat er moet gebeuren, maar het wordt een probleem als iemand op tactisch niveau moet gaan bepalen wat er met alle assets samen moet gebeuren. Dit is ook een proces van 6 jaar geweest. Daarbij moet gezegd worden dat DSO/TSO een gelukkige uitzondering is. Dat komt omdat zij wel grote, maar ook weinig spullen hebben, waar RNB's meer spullen hebben. Heeft u dit ervaren? Zo ja, hoe kwam het tot uiting? Tijd, geld of moeite? Waar kwam dit door? Welke eigenschappen/ karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke onderdelen van de norm hebben hiertoe geleid? Zo nee, kunt u zich hier iets bij voorstellen? Of past dit niet in het rijtje? Ja door de vele fusies is 50% van de informatie verdwenen. DSO/TSO is nu goed op track. Statische data is bijna compleet, maar dit is een zeker een langdurig proces geweest. De policy voor asset management moest gehaald worden uit een grote wolk van beleidsdocumenten met verschillende thema's. Niet alles was daarvan relevant voor AM, dus het was even zoeken naar de juiste stukken informatie. Daaruit zijn ook de doelstellingen gedestilleerd. Het filteren van juiste informatie was daarom een

0.1.1	250/750 611 11 11 11 11 11 11
Gebrek aan inzet/	DSO/TSO heeft hier niet echt problemen mee gehad. Vanuit het management was dit
betrokkenheid?	met up's en down's, maar over het algemeen was er geen gebrek. Het AMS is zelf
	geëvalueerd in 2010 om de resultaten te bekijken. De werknemers zijn overgenomen
	van RNB's, waar AM al meer in de organisatie gebakken zat en daar was dus ook geen
	sprake van gebrek. Een externe motivator verhoogt niet persee de betrokkenheid, maar wel de snelheid.
	Bij RWS was er wel tegenstand vanuit de werknemers richting de top van RWS, hier is
	dus wel sprake van gebrek aan commitment. Dit komt met name omdat een AMS toch
	wel redelijk top down zegt wat er moet gebeuren aan de SP.
Opstellen van duidelijke	Niet echt. Doelstellingen voor asset management dienen in principe te volgen uit de
doelstellingen?	doelstellingen van de organisatie in deze sector. In principe zijn de KPI's allemaal
docisteningen:	gekwantificeerd en bestaan daar dus geen misvattingen over.
Hogere kosten dan verwacht?	Nee, zelfs lagere kosten. Je krijgt aantoonbaar dat je bepaalde projecten naar achter
riogere Rostell dan verwaent.	kan schuiven, omdat ze obv de risico matrix niet zo urgent zijn. Er zijn geen extra
	kosten naar boven gekomen.
Meer manuren en tijd dan	Het traject duurde lang (van 2004 tot 2012), maar of dit veel langer is dan verwacht is
verwacht?	niet duidelijk. Iedere organisatie doet dit op een eigen tempo en bij DSO/TSO ging het
	niet heel hard.
Gebrek aan juiste kennis voor	Voor de interpretatie van de norm hebben ze zeker wel hulp gehad en daarnaast
implementatie?	konden ze kijken naar organisaties waar de norm al was geïnterpreteerd. De
·	interpretatie is dus nog wel een uitdaging, maar makkelijk op te lossen.
Problemen met audits/	DSO/TSO zelf heeft geen problemen gehad. Maar, je kan dan wel alles van een norm
assessors?	hebben geïmplementeerd, maar als je niet voorbereid bent op de vragen van een
	auditor, kun je zeker nog wel eens tegen problemen aanlopen.
	'Je weet 't wel maar je doet 't niet' OF 'Je doet/hebt het wel, maar je noemt het niet
	op.'
Voordelige resultaten n.a.v. de in	mplementatie van het asset management systeem
Open vraag voordelen	- Focus op de juiste dingen. Vooral het scheiden van de 3 rollen is belangrijk. De AO is
	nu namelijk veel meer bezig wat er van buitenaf speelt. De mondige burger, de strenge
	regulator e.d. hebben tegenwoordig veel mee invloed en alles wordt onder een
	vergrootglas gelegd. Hier kunnen ze nu veel beter mee omgaan.
	- Werk waarmee je eigenlijk niet zoveel opschiet wat betreft je targets, voer je niet
	meer uit.
Secundaire vragen	- Heeft u dit ervaren?
	- Zo ja, hoe kwam het tot uiting? Hoe gemeten? Na hoeveel tijd? Waar kwam dit door?
	Welke eigenschappen/karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke
	onderdelen van de norm hebben hiertoe geleid? - Zo nee, kunt u zich hier iets bij voorstellen? Of pas dit niet in dit rijtje?
Kosten verlagingen?	Het uitstellen van niet urgente projecten heeft tot 200 miljoen 'kostendalingen' geleid.
Kosten venagingen:	Als de informatie over huidige assets compleet is, wordt het makkelijker om kosten te
	gaan besparen op SP's. Tot nu toe heeft DSO/TSO hier echter weinig profijt van gehad.
	Kosten besparingen d.m.v. efficiëntere processen of het voorkomen van incidenten
Hogere asset onbrengst?	door betere risico beheersing weten ze niet.
Hogere asset opbrengst?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle
Hogere asset opbrengst?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is
Hogere asset opbrengst?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later
Hogere asset opbrengst?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar
	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen.
Meer en/of betere financiële	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je
Meer en/of betere financiële planning?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'.
Meer en/of betere financiële planning? Financiële voordelen in de zin	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij
Meer en/of betere financiële planning? Financiële voordelen in de zin	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid.
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit gewoon op elkaar aan nu.
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in operaties?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit gewoon op elkaar aan nu. Het is goed herleidbaar waar alles vandaan komt. Als dat onder communicatie valt, is
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in operaties? Verbeterde interne	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit gewoon op elkaar aan nu.
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in operaties? Verbeterde interne communicatie?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit gewoon op elkaar aan nu. Het is goed herleidbaar waar alles vandaan komt. Als dat onder communicatie valt, is dat zeker verbeterd. Iedereen heeft het over dezelfde dingen.
Meer en/of betere financiële planning? Financiële voordelen in de zin van premies, lagere rentes enz.? Verhoogde consistentie in operaties? Verbeterde interne communicatie?	door betere risico beheersing weten ze niet. Ze halen meer uit hun onderhoudsprogramma, doordat er een health index voor alle assets is opgesteld en hierop wordt beter gestuurd. In hoeverre dit uit het AMS komt is moeilijk te zeggen. Daarnaast zit hier en stuk relativiteit in. Je zou eventueel later kunnen testen in hoeverre je plannen hebben geleid to hogere asset opbrengsten, maar dat is nu moeilijk te zeggen. Ja, het achteruit schuiven van de niet urgente projecten is hiervan een voorbeeld. 'Je hebt inzicht over het totaal'. Zijn al wel gerapporteerd, maar DSO/TSO heeft hier nog geen profijt van gehad. Bij een rating wordt wel gevraagd of je een certificaat hebt, maar hoeveel het helpt, heeft hij geen idee van. Contracten met verzekeringen waren net verlengd, maar hij verwacht wel lagere kosten daarin. In Engeland gebeurt het zeker, o.a. bij National Grid. Ja. Komt zeker door het AMS, omdat de focus erin zit door de hele kolom. Als iemand iets anders gaat doen valt het op. Het hele proces is opgedeeld in stapjes en het sluit gewoon op elkaar aan nu. Het is goed herleidbaar waar alles vandaan komt. Als dat onder communicatie valt, is dat zeker verbeterd. Iedereen heeft het over dezelfde dingen. Documenten worden wel gefilterd op relevantie voor AM en zaken worden vastgelegd,

	worden gehangen. Dit verstevigd het besef. In tegenstelling tot bv. Liander, waar AM
	een afdeling is. Zij geven advies en wat er uitgevoerd wordt is niet persee wat AM heeft gezegd.
Verbeterd personeelsbestand?	Nee. Dit was al goed binnen DSO/TSO, ook het overgenomen personeel van andere
Telizetela pelisellesissestalla.	bedrijven. Geen resultaat geweest bij DSO/TSO.
Focus op continue	Bij een bedrijf als DSO/TSO wordt het ene verbeteringstraject snel opgevolgd door het
verbetering?	volgende, dus hier hebben ze nooit echt moeite mee gehad. Geen resultaat van het
	AMS.
Beter begrip en inzicht risico's?	Ja, absoluut. Vanaf het begin.
Verbeterde gezond- en	Heel moeilijk waarneembaar. Daarnaast is de vraag of dit significant aan je AMS ligt. Het
veiligheid werknemers en	is ook niet echt meetbaar.
publiek?	7-16d
Verminderde aantal en impact van incidenten?	Zelfde als hierboven. Zeer moeilijk waarneembaar en niet te herleiden naar het AMS.
Verbeterde nakoming van	Ja. Je let veel meer op wat er 'buiten' gebeurd. Het wordt daarnaast ook makkelijker
regelgeving e.d.?	om te sturen van bovenaf op een bepaalde regelgeving. Ook veranderingen in
	regelgeving zijn makkelijker.
Verhoogde transparantie?	Ja zeker. Zowel naar buiten toe als intern. Intern was het iets, wat pas op het laatst op
,	orde was. Naar buiten toe kunnen ze veel beter hun keuzes verantwoorden. Je komt
	niet overal mee weg tegenwoordig, je moet een goede onderbouwing hebben.
Verbeterd imago?	Hangt samen met bovenstaand punt. Ja, dit wordt wel makkelijker.
Verhoogde klant/ regulator	Regulator was eerst niet zo tevreden en nu minder ontevreden. Dus er is zeker
tevredenheid?	resultaat. Door de indeling van je organisatie volgens het AMS heb je een afdeling die
	zich bezig houdt met het beantwoorden van regulator vragen.
Verbeterde externe	Ja, want je hebt er nu iemand voor. De Asset Owner houdt zich hier nadrukkelijk mee
communicatie?	bezig en dit werpt z'n vruchten af.
Verbeterde management	Ja, het AMS leidt tot beter onderbouwde beslissingen en een verbeterde fit van
procedures?	strategie en uitvoering.
	plementatie van het asset management systeem
Open vraag nadelen	- Degene die was moet verzinnen (AM) en degene die dicht op de assets staat (SP) staan verder uit elkaar. Dat is lastig, want er ontstaat frictie door tegengestelde belangen.
	Daarnaast krijg je 2 interfaces (tussen AO en AM en AM en SP) en dat is minder
	efficiënt. Bovendien ga je dan dubbelwerk doen aan beide kanten van de 'muur'.
	Considering Seventien Suite authorized autho
Secundaire vragen	- Heeft u dit ervaren?
	- Zo ja, hoe kwam het tot uiting? Hoe gemeten? Na hoeveel tijd? Waar kwam dit door?
	Welke eigenschappen/karakteristieken van het bedrijf hebben hiervoor gezorgd? Welke
	onderdelen van de norm hebben hiertoe geleid?
	- Zo nee, kunt u zich hier iets bij voorstellen? Of pas dit niet in dit rijtje?
Te uitgebreide en	DSO/TSO heeft geen problemen gehad met excessieve hoeveelheden extra
bureaucratische	documenten door het AMS. Hier zijn ze ook principieel op tegen. 'Het is een kwestie van
documentatie?	hoe je ermee omgaat' en 'een systeem bouwen voor het systeem is nooit goed, dan
	moet je het systeem zelf veranderen'.
	Wel zie je dat door het scheiden van de rollen verzuiling optreedt en dingen dubbel
	worden gedaan. Dit gaat uiteraard ten koste van de efficiëntie.
	"Door de bomen zie je het bos niet meer". Quote van Sebastiaan Admiraal. Hij bedoelt
	hiermee dat nadat alle aspecten van het AMS geïmplementeerd zijn, het nog wel even
	duurt voordat hier ook daadwerkelijk interne transparantie uit voortkomt. In die tussen periode geldt dus dat het AMS niet perse meewerkt aan verhoogde transparantie.
Meer tijd en mankracht gekost	Meer tijd wel, want de culturele veranderingen die plaats moesten vinden duurden
dan verwacht?	gewoon lang. Geen extra mensen aangenomen voor of door het AMS.
	622
Meer geld gekost dan	Meer geld heeft het dus ook niet gekost. Zie potentieel obstakel.
verwacht?	
Tegenvallende resultaten/ te	DSO/TSO heeft hier geen last van gehad. Als je echter uit gaat van het theoretische
hoge verwachtingen	model, dan zou je kunnen verwachten dat de inbreng van competitie onder service
	providers de kosten omlaag brengt. Dit is echter nog niet echt gebleken. Het beter
	omgaan met de beperkte bewegingsvrijheid (motivatie) is goed gelukt.
Baten wegen niet op tegen de	Alles in intern gedaan, dus de kosten vielen mee. Voor DSO/TSO geldt dit niet.
kosten?	
Kritieke succes factoren voor de	
Open vraag CSF's	- Doorzettingsvermogen;

	- Besef dat het implementeren een cultuurverandering met zich meebrengt en het
	omgaan daarmee. Het herkennen is essentieel.
	- Het gebruik van interne mensen voor het implementatie proces.
Betrokkenheid gehele organisatie?	Absoluut belangrijk. Niemand kan zich eraan onttrekken binnen zo'n netbeheerder.
Organisatie van implementatie proces?	Ja is belangrijk. Het gaat niet vanzelf en er moet zeker iemand achteraan zitten.
Cultuur? Managen van culturele verschillen?	Ja, zie open vraag.
Leiderschap?	Ja is essentieel. De organisatie heeft leiderschap nodig om zo'n systeem er doorheen te krijgen. Het is echter niet meer essentieel voor de implementatie van een AMS.
Hulp van externe consultants?	Voor certificering zeker, omdat je niet geheel weet wat je kan verwachten. Voor implementatie is het zeker handig, omdat je zeker in een aantal valkuilen gaat stappen.
Begeleiding van CI?	DSO/TSO heeft de certificeerder een nulmeting laten doen en is dus als toetser al betrokken geweest bij het proces. 'Je hebt hem partner in crime gemaakt'.
Training voor personeel?	Ja, is wel belangrijk maar moet je ook niet overschatten. Mensen moeten wel de systematiek kennen. Beslissingen die van bovenaf worden gemaakt, moeten wel begrepen worden onderin.
Type motivatie? Intrinsiek vs extrinsiek?	Door extrinsieke motivatie komt er meer druk achter. Dit kan dus essentieel zijn voor de implementatie, maar hoeft zeker niet. Intrinsiek kan ook belangrijk zijn, maar is moelijk om te bepalen.
Ervaring met andere management systemen?	Ja, ISO 9000 is een makkelijkere opstap naar andere management systemen. Een aantal aspecten van een ISO kun je doortrekken.
Beschikbaarheid en bereikbaarheid informatie	Ja, absoluut.

Annex E: The Survey

Impact of asset management system implementation and certification Dear madame/sir, This survey is part of my graduation research project at the Delft University of Technology. The results will create insight in the impact of implementing an asset management system. An asset management system or AMS is defined as a set of interrelated or interacting elements of an organization to establish policies, objectives and processes to optimally manage its assets. Your answers will be kept anonymous and will only serve the scientific purpose of this research. I do ask you to fill in your company name, as this will enable me to take into account the type of company, its specific characteristics and its context (country, regulatory context, etc.) in my analyses. Completing the survey will take you approximately 10-15 minutes. Please be aware that "save & return" to the survey is not an option. If you would like to receive the results of my research, please fill in your e-mailaddress below. Thank you for taking the time to fill in this survey. Erik Gaarenstroom **Email address Basic information** * Function title * Company name * Type of company An asset management system or AMS is defined as a set of interrelated or interacting elements of an organization to establish policies, objectives and processes to optimally manage its assets. * Does your company have an asset management system (AMS) in place? 🔯 Yes ▼ * In what year did your organization decide to start implementing an asset management system? * Is your company's AMS certified? 🔝 Yes, with PAS 55 Yes, with NTA 8120 Yes, with ISO 55000 Yes, with a national standard Yes, with another norm/standard ■ No * Does your company have experience with implementing and certifying other management systems? 🔯 * Indicates Response Required

Impact of asset management system implementation and certification Progress: 17% Complete Motivation for implementing an Asset Management System (AMS) For the following questions, please try to remember what the initial motivations were to implement an asset management system. Below several possible motivations are displayed. Could you indicate to what extent the following aspects have initially motivated your company to implement an AMS? * 1. To reduce and/or optimize costs <a>I Not at all relevant Slightly relevant Relevant Very relevant * 2. To increase performance and output of existing assets Not at all relevant Slightly relevant Relevant Very relevant * 3. To maintain or increase the market share and improve the competitive postition of the organization 🔝 Not at all relevant Slightly relevant Relevant Very relevant * 4. To improve control over and professionalize internal processes 2 Not at all relevant Slightly relevant Relevant Very relevant * 5. To improve risk management Not at all relevant Slightly relevant Relevant Very relevant * 6. To answer to a top-down management decision 2 Not at all relevant Slightly relevant Relevant Very relevant * 7. To meet regulator requirements <a>[Not at all relevant Slightly relevant Relevant Very relevant * 8. To improve the image towards the public and/or stakeholders 2 Not at all relevant Slightly relevant Relevant Very relevant * Please note the most relevant motivation (may also be another than the ones mentioned above) and any additional comments on motivations below: * Indicates Response Required

Impact of asset management system implementation and certification

Progress: 33% Complete Challenges during the implementation of the Asset Management System During the implementation phase, several challenges in terms of time, money and/or effort might have surfaced. Please indicate to what extent your organization has encountered the following challenges during the implementation of the Asset Management system? * 1. Challenges related to information of existing assets 2 Not at all relevant Slightly relevant Relevant Very relevant * 2. Challenges related to organizational changes that come with the implementation of the AMS 🔼 Not at all relevant Slightly relevant Relevant Very relevant * 3. Challenges related to the fit of the asset management system in the existing organization 🔝 Not at all relevant Slightly relevant Relevant Very relevant * 4. Challenges related to the lack of commitment to the AMS 2 Not at all relevant Slightly relevant Relevant Very relevant * 5. Challenges related to setting adequate asset management goals and objectives 🔝 Not at all relevant
Slightly relevant
Relevant
Very relevant * 6. Challenges related to the lack of necessary knowledge for implementing a(n) (asset) management Not at all relevant Slightly relevant Relevant Very relevant * 7. Challenges related to meeting requirements for audits and assessors for the AMS 2 Not at all relevant Slightly relevant Relevant Very relevant * 8. Challenges related to the organization of the implementation process Not at all relevant Slightly relevant Relevant Very relevant * 9. Challenges related to keeping the system up-to-date and active in the organization 2 Not at all relevant Slightly relevant Relevant Very relevant * Please note the two most relevant challenges related to implementation (may also be others than mentioned the ones above) and any additional comments on challenges below:

* Indicates Response Required

Impact of asset management system implementation and certification
Progress: 50% Complete
Actual results of implemeting an Asset Management System (1/2)
Since the implementation of the Asset Management System the organization should have experienced some benefits from it. Please indicate to what extent the following positive effects are relevant to your organization due to the implementation of the Asset Management system ?
* 1. Cost reduction Not at all relevant Slightly relevant Very relevant
*2 hand described to the matter of
* 2. Improved financial decision making 2
* 3. Improved controllability and predictability of costs
Not at all relevant Slightly relevant Relevant Very relevant
* 4. Higher performance of assets
Not at all relevant Slightly relevant Relevant Very relevant
* 5. Improved business opportunities 2
Not at all relevant Slightly relevant Very relevant
* 6. Improved finance opportunities Not at all relevant. Slightly relevant. Palayant. Non-relevant.
Not at all relevant Slightly relevant Relevant Very relevant
* 7. Improved control over and transparancy in internal processes
Not at all relevant Slightly relevant Very relevant
* 8. Improved knowledge of existing assets 2
Not at all relevant Slightly relevant Relevant Very relevant
CO-respondent special control of the Production
* 9. Improved focus on/awareness of Asset Management
Not at all relevant Slightly relevant Relevant Very relevant
* 10. Increased focus on continuous (technological and procedural) improvement
Not at all relevant Slightly relevant Very relevant
_
* 11. Improved risk management Not at all relevant Slightly relevant Relevant Very relevant
Not at all relevant. Slightly relevant. Relevant. Very relevant
* 12. Improved morale and motivation of workforce
Not at all relevant Slightly relevant Relevant Very relevant
* 13. Improved health and safety
Not at all relevant Slightly relevant Very relevant
* 14. Improved public image and customer satisfaction
Not at all relevant Slightly relevant Relevant Very relevant
* 15. Improved ability to show compliance
Not at all relevant Slightly relevant Very relevant
* Please note the two most relevant positive results of implementing the AMS (may also be others than the ones mentioned above) and any additional comments on positive results below:
* Indicates Response Required

Impact of asset management system implementation and certification

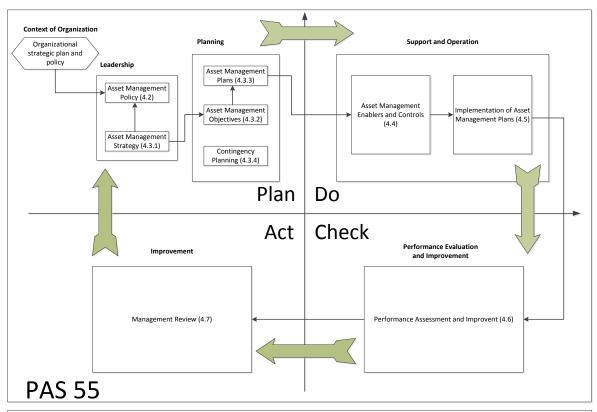
			Progress: 67% Complete
Actual re	sults of implen	neting an .	Asset Management System (2/2)
	stem. Please indicate	to what exten	n the organization might have experienced some t the following negative effects are relevant to your nagement system?
* 1. The AMS has led	to excessive and un	necessary do	cumentation, data gathering and bureaucratization
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 2. The standard prod	cedures are too rigio	?	
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 3. The implementati	on process takes or	has taken a l	ot more time and manpower than expected
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 4. The implementati	on process has cost	a lot more th	an expected 📴
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 5. People were dem	notivated by the orga	nizational ch	anges resulting from the implementation of the AMS.
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 6. The norm or stand	dard relies too heav	ily on people	and their interpretation 2
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 7. Expectations of th	e AMS were too hig	h 🔞	
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 8. The implementati	on of an AMS forces	the organiza	ation into compliance 📴
Not at all relevant	Slightly relevant	Relevant	Very relevant
* 9. The AMS introduc	es more complexity	in the organ	ization. 2
Not at all relevant	Slightly relevant	Relevant	Very relevant
			elated to implementing the AMS (may also be others omments on negative results below:
* Indicates Response R	equired		

Impact of asset management system implementation and certification
Progress: 83% Complete
Tragiand activities
Critical Success Factors (CSF's) for an Asset Management System
Please indicate to what extent the following factors prove or have proven to be critical for a successful implementation of the Asset Management system at your organization ?
* 1. Commitment of entire organization or asset management departments
Not at all relevant Slightly relevant Very relevant
* 2. The organization of the implementation process
Not at all relevant Slightly relevant Relevant Very relevant
* 3. Managing the cultural differences in the organization
Not at all relevant Slightly relevant Very relevant
* 4. Effective leadership by top management team
Not at all relevant Slightly relevant Very relevant
* F. Middle are a second constant and for the AMC 2
* 5. Middle management support/commitment for the AMS Not at all relevant Slightly relevant Very relevant
Not at all relevant. Slightly relevant. Nelevant. Very relevant.
* 6. Involvement of external consultants 2
Not at all relevant Slightly relevant Very relevant
* 7. Working with a certifying body at an early stage
Not at all relevant Slightly relevant Very relevant
* 8. Training and education of staff
Not at all relevant Slightly relevant Relevant Very relevant
* 9. Experience in implementing other management systems
Not at all relevant Slightly relevant Relevant Very relevant
* 40 lastinais matientina (7)
* 10. Intrinsic motivation Not at all relevant Slightly relevant Very relevant
* 11. Extrinsic motivation 2
Not at all relevant Slightly relevant Relevant Very relevant
* Please note the two most relevant Critical Success Factors (may also be other then the ones mentioned above) and any additional comments on Critical Success Factors below:
Thank you for completing the survey! Your results will be kept anonymous and only serve the scientific purpose of my research. If you would like to receive the results of my research, please fill in your e-mail address below:
* Indicates Response Required

Annex F: Overview of survey Respondents

Grid operator	Country	Type of company	Function	Start AMS	AMS certification	Since
TenneT	Netherlands	Electricity TSO	Risk manager	2012	NTA 8120/ISO 55000/PAS 55	2012
Liander	Netherlands	Electricity and Gas DSO	AM strategy	2004	NTA 8120/ISO 55000/PAS55	2008
Enexis	Netherlands	Electricity and Gas DSO	Senior Manager AM	2004	PAS 55/NTA 8120	2005
Endinet	Netherlands	Electricity and Gas DSO	Manager AM	2009	PAS 55/NTA 8120	2012
GTS	Netherlands	Gas TSO	Standardization Manager	2009	No	
Reliance Energy	India	Electricity DSO	AM process excellence	2012	ISO 55000	2014
Northern Ireland Electricity	Northern Ireland	Electricity DSO	Asset Manager	2013	PAS 55	2013
UK Power Networks	UK	Electricity DSO	Director Asset Management	2004	PAS 55	2006
Stromnetz Berlin GmbH	Germany	Electricity DSO	Head of System Management	2011	PAS 55	2013
Fingrid Oyj	Finland	Electricity TSO	Grid Manager	2004	PAS 55	2010
Amprion GmbH	Germany	Electricity TSO	Vice President	2005	PAS 55	2014
National Grid Gas Distribution	UK	Gas DSO	Network Innovation and Investment	2005	PAS 55	2007
National Grid	UK	Electricity and Gas TSO	Engineering Policy Manager	2006	PAS 55	2007
OÖ Ferngas Netz GmbH	Germany	Gas DSO	Asset Manger	2008	National standard	2008
Swissgrid	Switzerland	Electricity TSO	Head of Risk, Performance & Analysis	2011	No	
ENERGISA	Brazil	Electricity DSO	Systematic Optimization of Asset Maintenance	2012	No	
COMGÁS	Brazil	Gas DSO	Operations Director	2004	No	
ELES, d.o.o.	Slovenia	Electricity TSO	Ass. Director of AM Division	2012	No	
Eskom Holdings SOC Ltd	South Africa	Electricity TSO	Manager Maintenance Centre	2004	No	
GAS NATURAL FENOSA	Spain	Electricity and Gas DSO	Technical direction 2004 No		No	
Eandis	Belgium	Electricity and Gas DSO	Engineering manager	2008	No	

Annex G: Differences between PAS 55 & ISO 55000



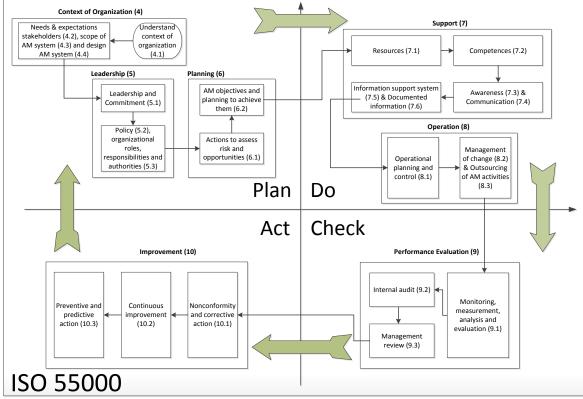
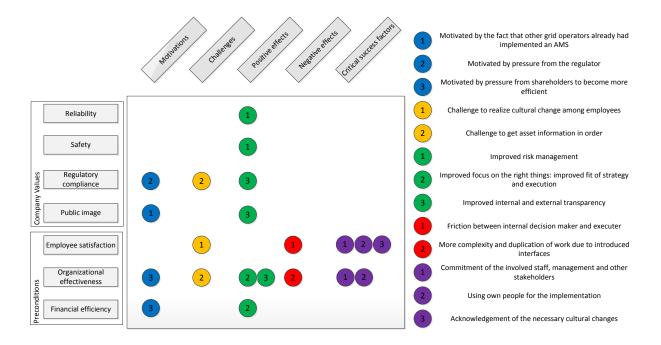


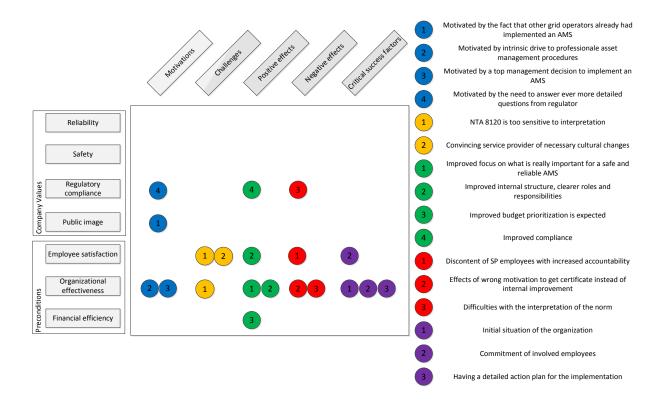
Figure 33: Visualization of the requirements in both the PAS 55 norm and the ISO 55000 norm, adapted from (Van den Honert, Schoeman, & Vlok, 2013).

Annex H: Impact Overviews of Dutch TSO's/DSO's

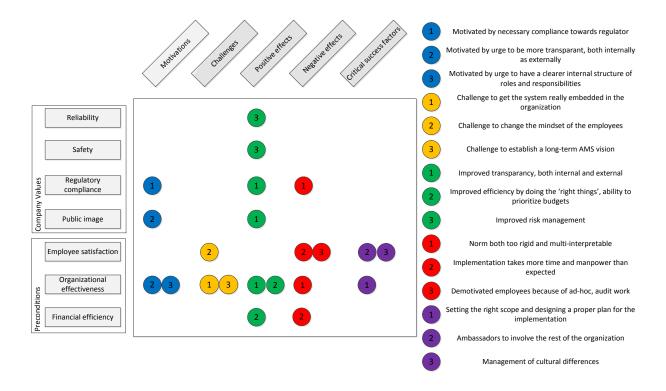
Dutch DSO/TSO 1



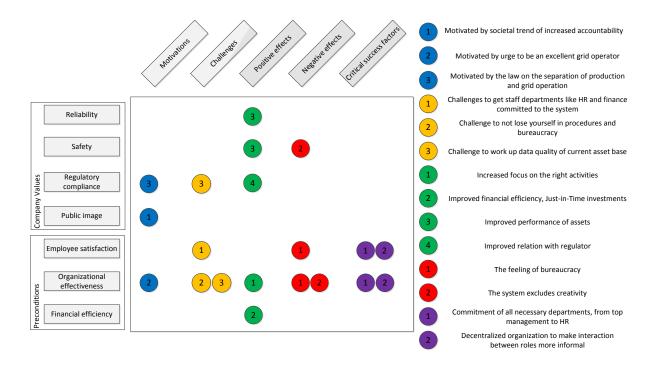
Dutch DSO/TSO 2



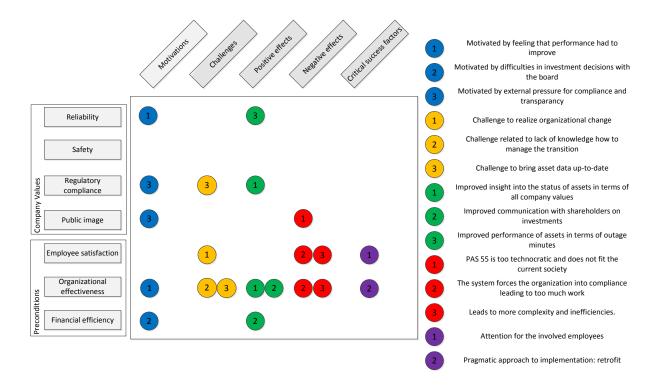
Dutch DSO/TSO 3



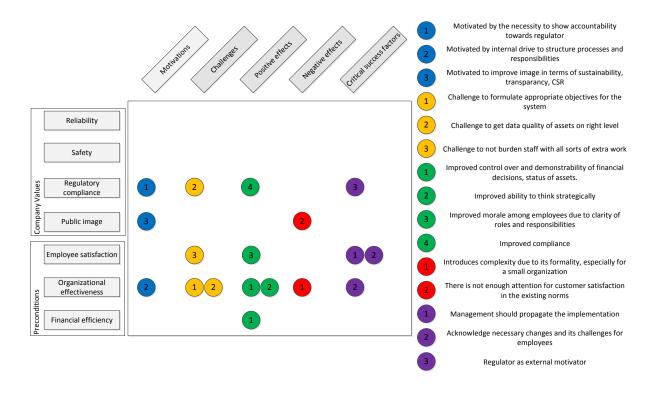
Dutch DSO/TSO 4



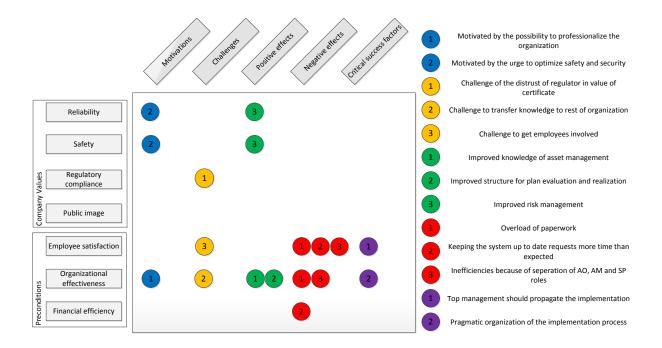
Dutch DSO/TSO 5



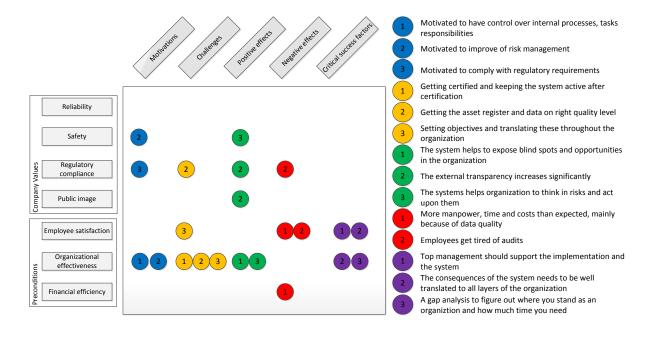
Dutch DSO/TSO 6



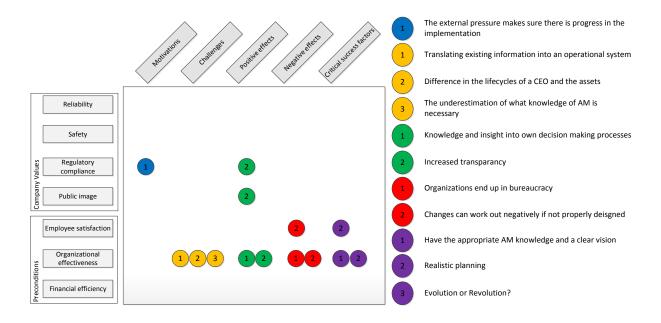
Dutch DSO/TSO 7



Dutch Regulator SodM



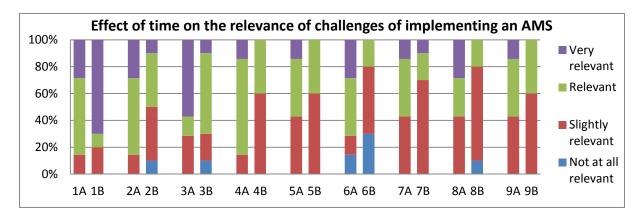
Certifying Institute



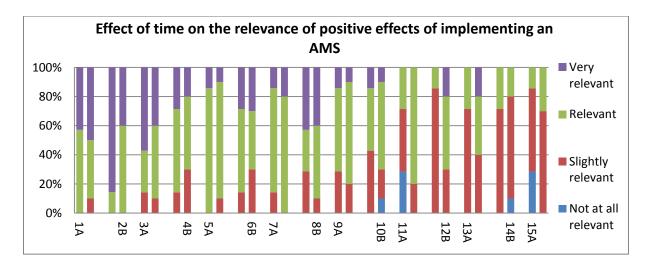
Master of Science Thesis

Annex I: Effect of Time on Impact of an AMS

Comparison of relevance of challenges, positive and negative effects between organizations certified after and before 2011.

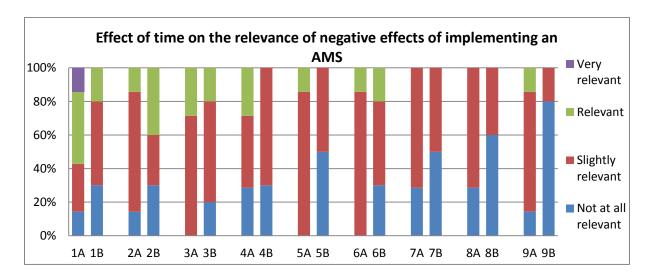


Rank	Impact factor	U1 (After)	U2 (Before)	Z-value	Significant (α=0,10)
1	Challenges related to information of existing assets	46	24	-1,07349	No
2	Challenges related to organizational changes	20	50	-1,46385	No
3	Challenges related to keeping system up-to-date/active	22	48	-1,26867	No
4	Challenges related to the fit of the AMS in organization	17	53	-1,75662	Yes
5	Challenges related to organization of implementation	27	43	-0,78072	No
6	Challenges related to the lack of commitment to the AMS	16	54	-1,85421	Yes
7	Challenges related to meeting requirements for audits	26	44	-0,87831	No
8	Challenges related to setting AM goals/objectives	18,5	51,5	-1,61024	No
9	Challenges related to lack of knowledge of AM/AMS	27	43	-0,78072	No



Rank	Impact factor	U1 (After)	U2 (Before)	Z-value	Significant (α=0,10)
1	Improved control over/transparency in internal processes	157,5	130,4	-0,466	No
2	Improved risk management	102	186	-1,499	No

3	Improved focus on/awareness of Asset Management	128,5	159,5	-0,535	No
4	Improved ability to show compliance	185,5	102,5	-1,432	No
5	Improved knowledge of existing assets	87,5	200,5	-1,949	Yes
6	Improved controllability and predictability of costs	168	120	-0,828	No
7	Increased focus on continuous improvement	89	199	-1,898	Yes
8	Improved financial decision making	132	156	-0,414	No
9	Higher performance of assets	134	154	-0,345	No
10	Cost reduction	135,5	152,5	-0,293	No
11	Improved health and safety	93	195	-1,760	Yes
12	Improved public image and customer satisfaction	105,5	182,5	-1,328	No
13	Improved morale and motivation of workforce	121	167	-0,794	No
14	Improved finance opportunities	99	189	-1,553	No
15	Improved business opportunities	84	204	-2,070	Yes



Rank	Impact factor	U1 (After)	U2 (Before)	Z-value	Significant (α=0,10)
1	The implementation has taken more time/manpower	20,5	49,5	-1,415	No
2	The implementation forces the organization in compliance	38	32	-0,293	No
3	The norm relies too heavily on interpretation	27	43	-0,781	No
4	The implementation has led to bureaucratization	27,5	42,5	-0,732	No
5	The AMS introduces more complexity in the organization.	15	55	-1,952	Yes
6	The standard procedures are too rigid	28	42	-0,683	No
7	The implementation process has cost more than expected	27,5	42,5	-0,732	No
8	People were demotivated by organizational changes	24	46	-1,073	No
9	Expectations of the AMS were too high	11	59	-2,342	Yes

Annex J: List of Abbreviations and Definitions

ACM	Authoriteit Cosument en Markt (Dutch consumer and markets authority)
AM	Asset Manager
AMS	Asset management system
AO	Asset Owner
DSO	Distribution system operator
EMS	Environmental management system
IAM	Institute of Asset Management
ISO	International Organization for Standards
MS	Management system
NAMS	New Zealand Asset Management Support
NTA8120	Nederlands Technische Afspraak 8120 (Dutch norm)
PAS 55	Publicly Available Specification (British norm)
PDCA	Plan-Do-Check-Act cycle
QMS	Quality management system
SEPAM	Systems Engineering, Policy Analysis and Management
SodM	Staatstoezicht op de Mijnen (Dutch state supervision of mines)
SP	Service Provider
TSO	Transmission system operator