# TOWARDS STRATEGIC ASSET MANAGEMENT

## MANAGEMENT AND MAINTENANCE WITHIN MUNICIPALITIES

*PUBLIC VERSION*

By

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in partial fulfilment of the requirements for the degree of

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“If the fear of failure prevents you from achieving your goals…

Then that *fear* becomes your failure.”

- …

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## Preface and Acknowledgements

This graduation research underlines the state of Asset management in the Dutch municipalities, and was commissioned by Infram BV, a leading consultancy firm in the fields of Mobility, Public Space and Water. Infram recognizes the integral importance of Asset management in the complex project environment, and their interests in this research topic lies in improved communication and counseling towards their clients, under which Asset Managers.

Asset management is an important subject in today's civil infrastructure industry. It covers a wide range of concepts in the maintenance of assets. However, due to its broad definition and interpretation, this research was narrowed down to Asset Management within Dutch municipalities. Infram was concerned with whether the municipalities performed their maintenance efficiently, and effectively. Experience in the field had led to the assumption that this was principally not the case. The question was derived on how they could consult and improve the current maintenance situation within the Dutch municipalities. My responsibility was to assess the current situation within municipalities and broadly analyze their situation based on the theoretical perspective on Asset management. What resulted was a laborious, and difficult graduation process. Nevertheless, this report marks the result.

This thesis could never be finished without the support and help of my graduation committee: Prof.Dr.ir. M.H. Hermans, Dr.ir. G.A. van Nederveen, Dr.ir. L.H.M.J. Lousberg, and Ir. A. Hage. First of all, I would like to thank Marleen Hermans for her guidance and her critical stance on the research process, and the report substance. Secondly, I am grateful my first supervisor Sander van Nederveen supported me during the whole graduation process. I have encountered many obstacles, however his personal approach combined with his in-depth knowledge has encouraged me throughout. Furthermore, my second supervisor Louis Lousberg has put me into place with his sober and rational mindset. His advice and in depth feedback has led to many iterations in the process, but it was for a good cause. In addition I would like to thank Adriaan Hage for his patience, willingness to mentor, access to his network, and his knowledge on the subject and research methodology. I also am thankful to Infram for the opportunity they have given me, and would like to thank Franklin Thijs in particular for his expertise on the subject of Asset Management.

My gratitude to all the participants of the interviews for their contribution, for their time and interests in this subject. To all the others, who have been part of my project, I send my thanks.

For her love and support, I would like to express my deepest gratitude to my girlfriend Kit-Yu.

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## Executive summary

The thesis follows a qualitative research approach among 11 Dutch municipalities to determine the current state of the Asset management rationale. It was aimed to evaluate what is needed to further state of Asset management within municipalities. This objective was derived from the observation that municipalities were aiming for identical goals; correct information, ability to talk with the political body, increased effectiveness and efficiency of their maintenance process, and the ability to make more considerate decisions. These elements are covered by the Asset management methodology.

The methods of analysis include qualitative theoretical funded research, and empirical interviews. By following a quote-research the interviews are analyzed and compared to the theoretical framework on Asset management and Change management.

It was discovered that the municipalities are not concerned with the technical changes towards Asset management, but instead struggle with persuading their internal organization for change in the maintenance process. Moreover, difficulties are in the explicit configuration of value in the performance of maintenance activities. The latter was derived from the inability to comprehensively translate strategic goals into practical objectives. Based on the social principles, a transition model was created for the municipalities to shift towards Asset management. The model consists of the most crucial process functions of Asset management, success factors of change, and a roadmap of transition. However, theoretical funded research combined with empiric data showed that within the process of change towards Asset management, 4 components are indicative and vital; (1) asset data system, (2) leadership, (3) communication, and (4) vision. When these components are properly coordinated within municipalities, a foundation is built for Asset management excellence.

Based on the research conclusions the recommendations include:

- Organize and structure the asset data system as the first step towards Asset management (outsource when needed)
- Value the short lines between departments, and acknowledge the internal organizational culture (emphasis on the organizational context)
- Improve the knowledge of employees, and focus on communication as Asset management should not be *another* empty methodology (overcome heuristic barriers)
- Focus on collaboration (with other municipalities). For small organizations this means adopting the best practices of the larger municipalities, who are in a better position to bear the risks of innovation.
- Social side of change is the foundation of Asset management. The technical side is the Asset management tool.

This research is limited in scope and exhaustiveness due to time constrains. Limitations include the broad empirical research execution of the interviews within the municipalities. This is reflected in the fact that in most cases merely one interviewee was interviewed per municipality. However, this was done deliberately as it was not the core objective to analyze the maintenance process of the municipalities in depth, but rather to gain an indication of the overall maintenance approach of municipalities in the Netherlands.

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# Chapter 1 **Introduction**

*This chapter will outline the background of the research area. Moreover, the most important domains within the thesis are addressed.*

In the Netherlands Rijkswaterstaat (RWS), the provinces, municipalities, and water authorities are the owners of infrastructure portfolios. A shared ambition is that they aim to reduce public expenditure while maximizing the outcome. In maintenance it comes down to optimizing the way public resources are managed and budgets are allocated. Gradually, we're shifting from 1-on-1 asset replacement projects towards a combination of "*functional preservation, functional alteration and largely functional improvements*" in our core maintenance strategy (Koshiek et al., 2015, p. 15). This is a proactive maintenance approach, in which a continuation of the functionality of the system is preserved rather than correcting an inspected fault (van der Velde, 2015). This mindset results in a conscious assessment of maintenance in order to determine what maintenance is worthwhile, and moreover what is efficient and effective. Nevertheless, the users of the infrastructure network expect a certain performance of the total asset network. Including but not limited to safe, and accessible infrastructure. It is in the interest of a public sector organization to gain insight in what maintenance is vital, and how they should allocate their financial resources, while still conforming to the set expectations of the public.

In this thesis a study is performed to assess the issues the municipal asset managers face in their maintenance activities. A key focal point is to assess whether people involved in the maintenance process understand how their input contributes towards the whole network. Thijs (2013) mentioned that an organization usually is "*entangled in fixed patterns, and their own approaches… The people are focused on preventing or mitigating potential risks and setbacks. This conservatism may counter the process of change".* This view revolves around the assumption that people know what their responsibilities are, and what is expected from them, but the transition from the old to the new regime could lead to a creep of inefficiencies, and incorrect behavior. An approach without a clear top goal, leads to a loss of contextual oversight.

In the following section the context and background of the research subject is described. Thereafter, in the chapter *Research design* the extent and direction of the research is outlined.

## 1.1 Social and public value

As of 2017, there are almost 390 municipalities in the Netherlands[1]. They carry out tasks that directly affect and is in the interest of the local residents (Rijksoverheid, 2016). It is therefore irrefutable that good governance is of vital importance. The legitimacy of the government, and thus the public trust, is at stake when the governance is in question. Especially in times of vast austerity measures, and the changing role of the municipality, it is expected that value-based conflicts with the public will happen more frequently. A more detailed explanation on value is included in Appendix J, section II.

In infrastructure, the municipality is regarded as an asset owner. The infrastructure asset owners are encouraged to maintain their assets in a good condition (in accordance with the '*wegenwet',* roads act). They are legally accountable for any incurred damages by the infrastructure users (art. 6:174 BW). In addition, the infrastructure asset has to meet the level of service expected by the public. However, there is an "*asymmetry in cost and benefits*" in infrastructure (Y. C. Wijnia & Herder, 2012, p. 33). It refers to the fact that infrastructure owners pay for and invest in assets while they do not directly benefit from this investment, as they are not the direct users (Y. Wijnia

[1] https://www.cbs.nl/nl-nl/onze-diensten/methoden/classificaties/overig/gemeentelijke-indelingen/indeling%20per%20jaar/gemeentelijke-indeling-op-1-januari-2017

& de Croon, 2015, p. 4). This has been a root cause of most value-based conflicts between public and municipalities. It should be made clear to what extent investments in infrastructure maintenance has contributed towards the public value, and even the social value.

***Value in the infrastructure sector***

The efficiency and effectiveness of maintenance is a subject that has been researched a lot in recent years. In 2009 the Randstedelijke Rekenkamer, an organization concerned with improving the functioning of the provincial government, issued a research into the effectiveness of the provincial policy in maintenance, and maintenance management of civil engineering structures (Randstedelijke Rekenkamer, 2009). One of the partial findings of the research group was that the maintenance activities were to a lesser extent executed methodological. It implies that the Province displayed many characteristics of effective maintenance, however the relation between the planned activities, and executed maintenance activities were not clear. As a result they were unable to determine whether the maintenance activities were in line with the performances, and goals of the Province (Randstedelijke Rekenkamer, 2009, p. 68). This was also found in a research performed by Y. C. Wijnia and Herder (2010). They studied the state of Asset management implementation in the Dutch sector, and found that AM had stagnated at the tactical level, and has yet to reach the strategic level. They concluded that there were still difficulties in alignment "*between organizational (strategic) goals and the technical asset performance criteria*" (Y. C. Wijnia & Herder, 2010, p. 9). Another important recommendation of the Randstedelijke Rekenkamer was that the provinces should have determined their maintenance planned ('planmatig'), instead of budget focussed. Thereby the objectives, performances, and the operational maintenance will be better aligned.

The line of thought is based on an adaption of the Asset management principles. It regards a conscious balance between performances, risks, and budget. Approaching it from a functional standpoint, decomposing the public values into objectives, and furthermore functions of the infrastructure, a better assessment can be made in maintenance (Figure 1-1). In addition, the system performances, influenced by the maintenance activities on an operational level, can be related to the overall public values. This linkage could provide insight in how maintenance budgets relate to the risks of insufficient asset performances.

In § 1.2 the Asset management concept is shorty introduced, thereafter the remaining definitions resulting from Figure 1-1 are assessed.

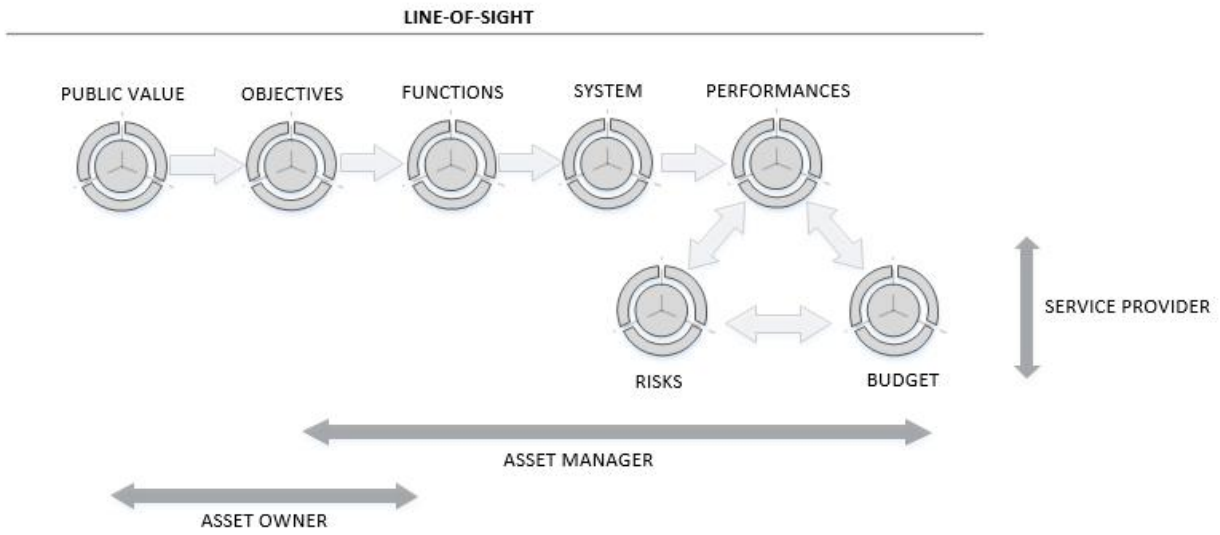



**Figure 1-1 Line of Sight, adapted from Huerne and Willems (2011, p. 13)**

## 1.2 Asset management concept

The driving idea behind **Asset management** (AM) is to increase the maintenance efficiency, and drive down the costs. In the infrastructure sector Asset management is often seen as a tool to reduce costs. However this perception is based on the wrongful assumption that the gains can only be expressed in monetary terms. Explaining the concept of Asset management is challenging, because it is often differently interpreted throughout industries, regions and even between organizations. A form of guidance on Asset management can be found in the publication of the NEN-ISO 55000 series, the successor of the PAS-55. The NEN-ISO 55000 standard defines Asset management as follows (International Standards Organisation, 2014a, pp. 19-20):

"*Coordinated activity of an organization to realize value from assets"* in which the assets are defined as an "*item, thing or entity that has potential or actual value to an organization".*

The guideline only makes reference to what is required to implement AM rather than how it can be achieved. A consequence is that the organizations are still struggling with the question on how they can implement AM and moreover, what it exactly is (Y. C. Wijnia & Herder, 2010). Based on preliminary research among a number of municipalities, the same difficulties regarding AM, and maintenance, can be found throughout the governmental layers. There is a strong will to improve the efficiency of maintenance, and maintenance management, but its implication is still underexplored in the governmental organization.

***Optimizing maintenance***

The asset manager is challenged to maximize the public value with limited resources. Whether it is about infrastructure, or other sectors, the methodology are in way very similar. AM offers an integrated and systematic approach to build, acquire, manage and maintain civil engineering structures. The systems are aimed at fulfilling the functional and public values fitting its unique context.

As an alternative to stating the core elements of an Asset management process, the core principles of Asset management in the infrastructural industry is given (NCHRP, 2006, p. ii):

- **Policy-Driven**: Resource allocation decisions are based on a well-defined and explicitly stated set of policy goals and objectives.
- **Performance-Based**: Policy objectives are translated into system performance measures.
- **Analysis of Options and Trade-offs**: Resource allocation decisions are based in understanding how different allocations will affect the achievement of policy objectives.
- **Decision Based on Quality Information**: The different options with respect to an agency's policy goals are evaluated using credible and current data.
- **Monitoring to Provide Clear Accountability and Feedback**: Performance results are monitored and reported for both impacts and effectiveness.

From a practical perspective the strategic level of Asset management regards the 'line of sight' entailing an optimal linkage between the "*user expectations for systems condition, performance, and availability with system management and investment strategies"* (FHA, 2007, p. 3). The objectives need to be determined on a strategic level and should fit the organisation. Subsequently, these are translated to the lower levels. The distinct roles on each level is the Asset Owner, Asset Manager and the Service provider (Figure 1-2) (Klatter, Velde, & Bakker, 2010, p. 257). The Asset Owner is responsible for establishing the strategic policy goals such as determining the relevant stakeholders, budget allocation, added value towards an organizations vision and separating the acceptable and unacceptable risks. The Asset Manager uses the strategic policy goals as boundaries for decision making. He will evaluate the severity

of the risks and impose mitigations actions. In the end the Service Provider is responsible for the actual implementation (Roestenberg, de Croon, & Meerman, 2005, p. 60).

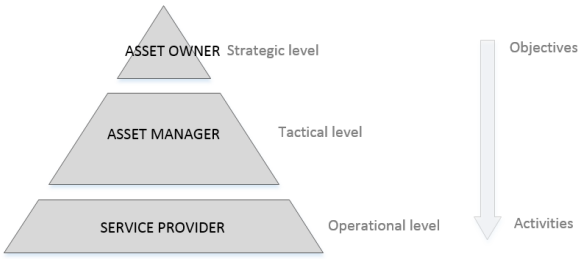



**Figure 1-2 Hierarchy on three levels**

### *Planned maintenance in Municipalities*

A terminology frequently used in the Dutch industry is "*Planned maintenance*". Gemeente Tilburg (2015, p. 23) defines planned maintenance as "*maintenance that is set out per activity in time and finances, and focuses on the function fulfilment of the object*". Veldman (2011, p. 65) defines the term as proactive maintenance, which can be both preventive as predictive. It refers to that determining maintenance activities should not only be based on a failure response, but instead on interval maintenance, age based, condition based opportunistic maintenance, and reliability centred maintenance (Kothamasu as cited in Veldman (2011, p. 65)). Randstedelijke Rekenkamer (2009, p. 13) argues that planned maintenance focuses on efficient, and effective maintenance. The criticality of a maintenance activity is covered by the term effective. The effectiveness is measured based on its compliance to the related objectives (Randstedelijke Rekenkamer, 2009, p. 73). Using this definition, we can argue that planned maintenance is to a certain extent similar to Asset management. In AM the creation of value is endeavoured by balancing the risks and performances of assets with the strategic objectives. With planned maintenance the efficiency and effectiveness of maintenance is endeavoured by balancing the risks and performance of assets with the related objectives. In short, we are able to state that the core principles of both are identical on a high abstraction level. Nevertheless, it should be noted that AM is broader and incorporates more concepts than the definition given.

The Rekenkamercommissie (2009, p. 12) has specified how Planned maintenance on a high abstraction level can be interpreted within a municipality. It considers the political hierarchy, responsibilities, and generic documents available within municipalities (Figure 1-3). Globally, it includes three major documents; a Policy program by the Asset owner, Management plan by the Asset manager, and an Annual plan by the Service provider.

- **Policy Program**: The domain of the strategic decision-maker. The document is established by the Municipal Council (Gemeenteraad) in a municipality, representing the vision on maintenance of the municipality. It outlines the medium and long-term outlook for maintenance and contains the strategic and operational objectives, level of maintenance, priority of maintenance, financial resources, and the desired state of the asset network after a certain time period (Rekenkamercommissie, 2009, p. 12).
- **Management plan**: On a tactical level the management plan is created, and eventually established by the Board (College). It takes the strategic objectives and boundaries from the Policy program and translates them into the short-term performance and maintenance measures (Rekenkamercommissie, 2009, p. 12).
- **Annual plan**: The annual plan outlines the most concrete and operational maintenance measures (Rekenkamercommissie, 2009, p. 12).

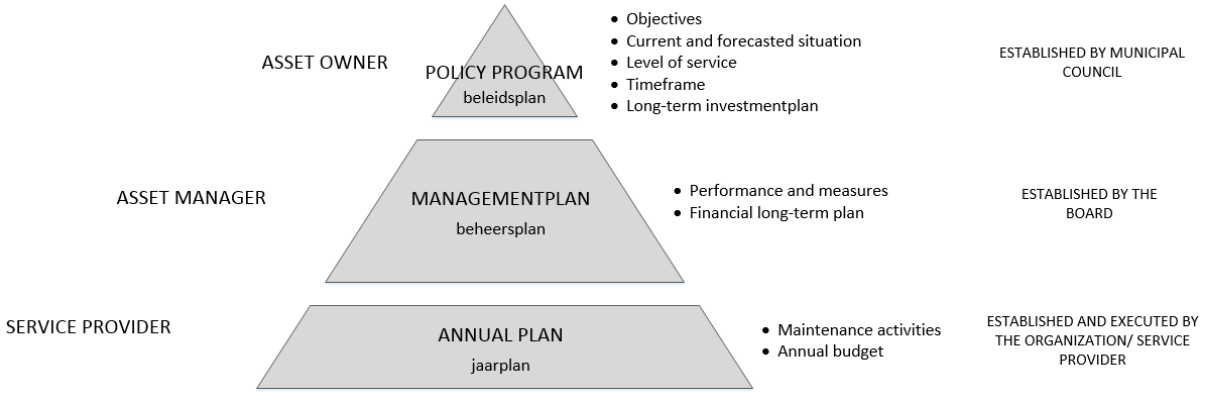



**Figure 1-3 Planning process Municipalities, adapted from Rekenkamercommissie (2009, p. 12)**

However, the figure above should only be used as a mean to clarify the process on a high abstraction level. Only creating the program, and following such planning process is by itself not sufficient to comply with 'Planned maintenance'. In a point made earlier it was argued that Planned maintenance, taken from the definition given by Veldman and the Randstedelijke Rekenkamer, corresponds with the definition of Asset management given in the NEN-ISO 55000. Stehpen Morris, the president of the Institute of Asset Management (IAM), stated that "*the value of assets (in Asset management), is their contribution to achieving explicit business objectives*" (as cited in Davis (2012, p. 1)). The use of the term '*explicit*' is important, because it refers to a strong, and logical translation of decision making between each hierarchy and policy documents. Therefore we can conclude that municipalities are aiming for maintenance effectiveness, and efficiency. Effectiveness is the filtering process to identify the critical maintenance measures adding value to an organization's asset, by focusing on the objectives (more on objectives in Appendix J, section IV). Efficiency is reached by offsetting the effectiveness of the activities against the required financial resources.

## 1.3 Functionalities

Huerne and Willems (2011) stated four main components vital for addressing a system from a functional standpoint; Functions, System, Performances, and Level of Service (more on Functions in Appendix J, section V). The Level of Service decided upon is based on balancing the performances, with the risks, and budget. In Figure 1-4 we can assume that the left side from Public value to Functions describes the outcome, while the right emphasizes the output. It is crucial that there is an explicit linkage between outcome, and output. Nevertheless, this model shows that the impact of a maintenance activity resulting from balancing the performances, risks, and budget can be made explicit as it shows a direct relation towards the public value of an organization. Figure 1-4 is further completed with an iterative process referring to the significance of monitoring within Asset management (Plan Do Check Act).

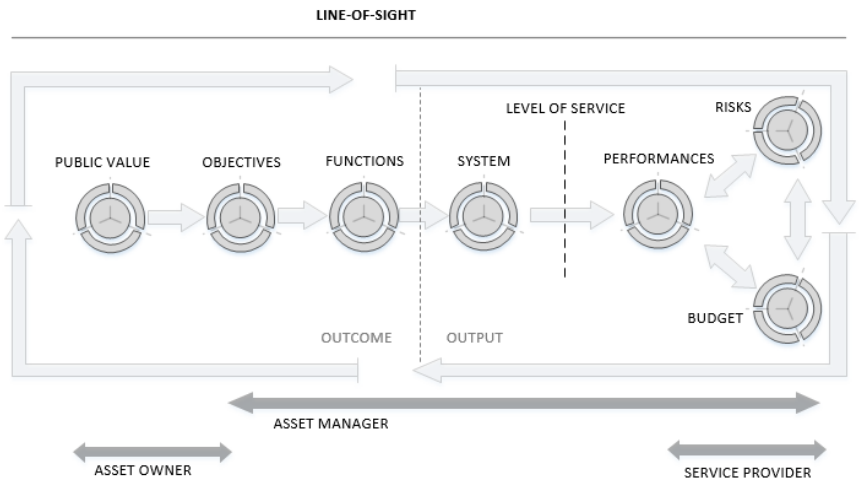



**Figure 1-4 Adjusted Line of Sight**

## 1.4 Summary

We are facing an era with vast austerity measures. People are demanding and expecting more, while funds are slim. In 2012, a coalition agreement called 'Building Bridges' ('Bruggen slaan'), was approved that called for a structural reduction of governmental spending of up to 1.1 billion euros (Algemene Rekenkamer, 2013, p. 2). In 2013, the Algemene Rekenkamer concluded after an investigation into the budget cuts among 22 executing agencies, including RWS, that the Second Chamber is insufficient aware of the impact of the budget cuts and called for more explicit stated consequences (Algemene Rekenkamer, 2013, p. 13). On another note, the Randstedeljike Rekenkamer found that the provinces were not able to sufficiently substantiate those consequences as the relation between the planned activities, and executed maintenance activities were not clear. It seems that both the Algemene Rekenkamer and the Randstedelijke Rekenkamer are pushing an agenda in which the line-of-sight is crucial in substantiating the goals, causes, and effects within maintenance.

Currently there is a shift from 1-on-1 asset replacement projects, and corrective maintenance towards planned maintenance (predictive). The Randstedelijke Rekenkamer (2009, p. 13) states that with planned maintenance, the emphasis lies on an object's functionality rather than the object itself. The core principle of planned maintenance, as determined by definitions given by multiple authors, is an efficient and effective maintenance, while that of Asset management is the creation of value. Based on the definitions given in this chapter for both terminology we stated that planned maintenance is to a certain extent comparable to Asset management, as they both aim for explicit compliance with the strategic objectives. The researcher therefore believes that a linkage between the organizational objectives to maintenance activities through the line of sight, is crucial.

In this thesis an assessment is made on whether the stated argument is true for municipalities; do they perform maintenance from an Asset management perspective, and are they able to explicitly link their strategic objectives with their maintenance activities (line of sight)?

# Chapter 2 **Research Design**

*In the previous chapter a first step is made towards the research problem. However, to determine the specific theoretical and practical value of this research, a conceptual research model is established in accordance to the given research guidelines by Verschuren and Doorewaard (2007).*

## 2.1 Problem statement

Researchers such as Wijnia and Herder, and independent bodies auditing the efficiency of governmental (municipal) expenditures, Randstedelijke Rekenkamer, all stated that current attempts of maintenance in the Netherlands have not yielded the desired results. Y. C. Wijnia and Herder (2010) in specific have conveyed that efficiency improvements can be gained by transitioning towards strategic Asset management in which there is a clear line-of-sight from top to bottom. It is remarkable that municipalities are currently lacking a strong Asset management foundation, even more as they have to substantiate their expenditures of public funds[2]. One could ask why they are currently lacking behind, and why it is so difficult to achieve change. An assumption made is that municipalities do not interpret the lack of Asset management as a problem within their maintenance process[3]. In order to aid the municipal transition process towards 'higher-level' maintenance, a thorough analysis should be done among a number of municipalities to assess their viewpoints. How can they implement the corner stones of Asset management, and what can they learn from each other?

The problem statement is as follows:

> *Municipalities in the Netherlands are currently examining opportunities to improve the efficiency and effectiveness of their current maintenance processes, as historic approaches have led to overdue maintenance[4]. However, in order to improve the maintenance and create value, they need to link the strategic objectives to the maintenance activities. Preliminary research has shown that this step towards strategic Asset management is an immense challenge that puts strain on the organization, and the people.*

## 2.2 Practical and Scientific relevance

The efforts of organizations to attain and sustain a competitive advantage in the changing environment, as well as the level of adaptation required, is often regarded as a complex and uncertain undertaking. Chesbrough (2006) described in his article "*The Era of Open Innovation*" the fundamental ways companies are rethinking their current processes to generate ideas. He stated that they are increasingly adopting ideas from other firms and sectors to improve their current business. This is an important principle, as they gradually focus on the adaptation of processes rather than trying to 'reinvent the wheel'.

[2] Empirical research; Statement based on preliminary research among a number of municipalities
[3] Emperical research: the use of the AM terminology was in some cases waved aside. Moreover, not all municipalities were interested in an interview on this subject.
[4] For instance, Rekenkamer Breda (2013, p. 1), Gemeente Ede (2016, p. 11), and Gemeente Rotterdam (2015, p. 41).

In the infrastructure industry, organisations are adopting new methodologies for process improvements, such as; Systems Engineering, Lean, Agile, or Asset Management. The foremost reason to adopt these practices is to increase an organizations efficiency, and thereby drive down the costs. However, with AM in particular, a thorough transformation of an organizations structure (on all layers) is required. Asset Management within the municipal governmental layer is a novelty and offers room for research. The enactment of AM during maintenance is not (yet) an obligation put out by the government, but implementation in other industries has shown that it could definitely be beneficial. As a result we can see different AM maturity levels among municipalities. It is useful to assess what the foremost considerations are when a municipality chooses to adopt AM, and which practical problems they have identified.

In this study a method is used to enable the researcher to come up with an approach to support the transition process of municipalities towards Asset Management. It is described as a process in which the core problems of current AM implementation in a municipal organization is identified, and factors linked with these transition goals are revealed.

Its practical relevance can be found in a recommendation on how small governmental organizations could deal with Asset Management implementation. Especially for consultants, who are often contracted by organisations to support developing Asset management programs and improvement plans, could gain insight into why initiatives fail.

Its scientific relevance is gained in new insight on specific problems that enables efficient organizational transition in a technical environment. Research on 'Planned maintenance' among provinces, and municipalities in the Netherlands are plenty fold[5], but research specifically into the translation process of maintenance in municipalities in accordance with the line-of-sight has yet to be conducted.

## 2.3 Research objective

Verschuren and Doorewaard (2007, p. 33) stated that every research has a core objective; contributing towards the existing theory, or making a contribution to solving a practical problem. In this graduation research both fields are affected. The objective is formulated based on five components stipulated by Verschuren and Doorewaard (2007, p. 36); "*Useful, realistic, achievable, unambiguous, and information rich*".

The Research objective is as follows:

> *The main research objective is to determine the current state of the maintenance process in the Dutch municipalities based on the strategic linkage between the organizational objectives and maintenance activities, and propose how the municipality could effectively further implement an Asset management process to improve the strategic link.*

The research objective is partially based on a statement given by Y. C. Wijnia and Herder (2010) indicating that organizations are struggling with the question on '*how*' AM can be implemented, as in current guidelines there is a greater emphasis on the '*why'* and '*what'*.

[5] Research of Rekenkamer, Randstedelijke Rekenkamer, Algemene Rekenkamer in Flevoland, Noord-Holland, Utrecht, Zuid-Holland, Groningen, Amsterdam, Breda, and Hoorn.

## 2.4 Research question

The question following the research objective, and that gives direction towards the research is:

> *How to contribute towards an improved strategic steering of maintenance within the Dutch municipalities by identifying key components aiding the change process towards Asset management?*

The research question is answered by the following sub-questions (SQ):

> *I. What are the cornerstones of Asset management?*
> *II. What are the key factors required for the Asset Management transition process?*
> *III. How is Maintenance organized within a Municipal organization?*
> *IV. Which key factors could hinder the transition process for municipalities?*
> *V. What are the fundamental causes of those factors?*
> *VI. How can we facilitate the transition process towards Asset management for municipalities?*

## 2.5 Research Scope

In this research a general assessment is made on Asset Management implementation among a number of municipalities in the Netherlands. The assumption is that every organization (municipality) carry out elements regarded as Asset management within their current maintenance processes. Asset management is a broad term covering numerous processes and activities. It is therefore improbable that an organization executes maintenance activities and follows maintenance processes without showing some key Asset management characteristics. Thus the research is;

- Intended for local governments (municipalities), and engineering consultancy firms
- Narrowed down to the context of Dutch municipalities regarding the management of their (infrastructure) assets
- Dependent on empirical research
- Limited by the time constrains of the research
- Intended to assess the current maintenance activities within the Dutch municipalities, and identify the gap between the theoretical AM process and the practical fulfilment

The objective is to identify an approach that aids the transition process among the municipalities, and provide practical solutions based on the identified key components.

## 2.6 Research method

To fulfill the research objective and to be able to answer the proposed research question, the research methodology and strategy will be described. It will provide an overview of the intended approach and will give insight in the necessities to finalize the research. There are various research strategies useable in a research. Verschuren and Doorewaard (2007, p. 159) acknowledges five general types: survey, experiment, case study, funded theoretical approach, and a desk research. More on the research methodology in Appendix J, section VIII.

In a research it is not always possible to follow one distinct research methodology or strategy. In most cases mixed methods are utilized to confirm a hypothesis or answer the research question. At the highest abstraction level, this research in particular is labeled as a qualitative theoretical funded research, whereas it has a descriptive nature assessing the maintenance methods employed in the municipalities and thereby combining elements of theory and empirical

research. The main sources of information are literature, (semi-)structured interviews, and Asset Management professionals. Based on theoretical and empirical findings, the research model is evaluated during the whole process in order to adjust it where needed. To clarify the approach adopted, each chapter in this report starts with a chapter methodology to determine and elaborate upon the chosen research approach.

## 2.7 Research model

In this section a research model is formed. The research model is a graphical representation of the research process, and enables and forces the researcher to describe the required research stages. The research is divided into five unique stages. Each stage represents a milestone during the research, and is set out against the time in a project schedule (Appendix A). The research stages are elaborated in the next section.

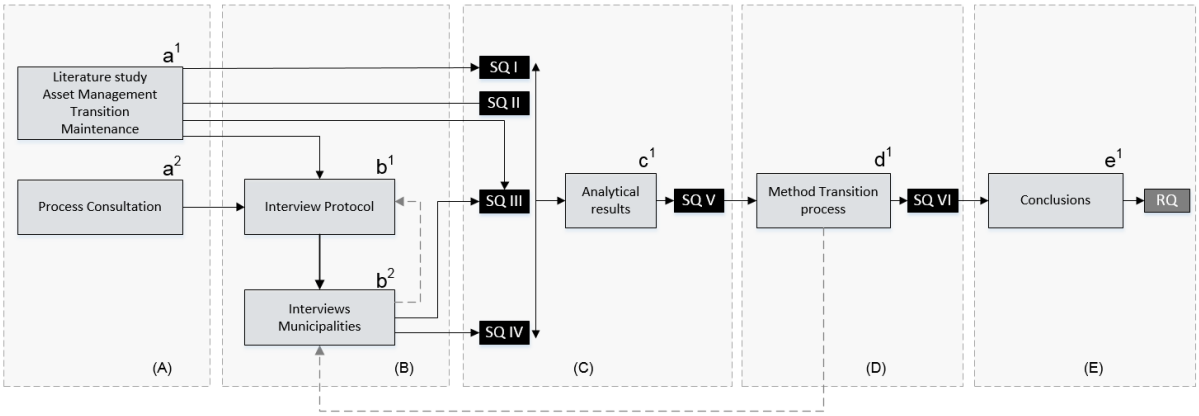



**Figure 2-1 Research model**

***Stage A***

The first stage in this research project is characterized by a theoretical literature study on Asset management, and informal discussions with the research company; Infram. In addition the municipality (interviewee 1, Appendix C) is approached to test the interview protocol and to elaborate upon it when needed. Furthermore, in stage A, a problem is formulated that meets the scientific relevance required by the university, and the practical applicability sought by the research company. Data used in this stage are drawn from various sources such as digital and paper documents, exploratory interviews, and informal discussions.

In order to grasp the AM methodology, research papers on AM are reviewed. Early literature study has revealed that the taken direction on Asset management by Huerne and Willems (2011) is promising for the scope of this research. They have created a model showing the line-of-sight (line of thought) of strategic goals towards the maintenance activities. With minor adjustments this model is adopted for municipalities as the core of this research. Further study has yield various vital reports on 'Planned maintenance' in governmental organizations (i.e. Randstedelijke Rekenkamer (2009)). The Rekenkamer, an independent organization concerned with controlling the government on their effectiveness and efficiency, has given

insight in the structure of municipalities, and the prevailing rationale within the governmental organization from the 'Planned maintenance' perspective.

The results of stage A contains the answers on the sub-research questions I and II.

*Results*
- SQI: What are the cornerstones of Asset management?
- SQ II: What are the key factors required for the Asset Management transition process?

***Stage B***
In this stage the interview protocol is developed using input from the theoretical framework, and initial exploratory interviews (attached in Appendix C). The core structure of the interview regards questions related to the line-of-sight, and the transition process towards Asset management. Moreover, the interviews are conducted in an unstructured manner with open-ended questions. In contrast to structured interviews, which are characterized by a set of prescribed questions, the unstructured method adapts the questions based on the interviewee and the setting of the interview (Emans, 2002, p. 124). A combination of both are applied to keep the goal and anticipated outcome of the interviews clear, but allows the interviewee to focus on subjects he regards relevant and important. Therefore the questions and the way these questions are asked can vary. The transcript of these interviews is appended in Appendix C, section I.

The interviews are conducted in two rounds. In the first round 13 interviews were conducted with employees of 11 different municipalities (Appendix B, section I). Later on in the process, supplementary interviews were conducted with individuals mainly active on the strategic level of the municipalities interviewed in the previous round (Appendix B, section II)..

The interviews are conducted within several municipalities ranging in size, relative geographic location, and the extent of Asset management implementation. The interviewees within the municipalities are chosen as a sample group based on their function within the organization, and their willingness to participate in the research. They include Asset managers, maintainers, program managers, and consultants (heavily involved in the AM or maintenance process of a musicality).

The criteria of selection are:
- The interviewees are knowledgeable about the maintenance process of the municipality
- Municipalities vary in size, geographic location (within the Netherlands), and AM implementation.
- The profession of the interviewees is relevant, and important within the strategic chain of maintenance (line-of-sight). They could include the Asset Managers, Maintenance policy officer, Team leaders of a relevant discipline, or consultants in the AM or maintenance field.

The results of stage B includes an interview protocol, transcript of interviews, and an answer on sub-question IV. In addition, sub-question III is answered based on the results of Stage A, and B.

*Results*

- Interview protocol
- Interviews

- SQ III: How is Maintenance organized within a Municipal organization?
- SQ IV: Which key factors could hinder the transition process for municipalities?

***Stage C***

In stage B it was identified how municipalities have organized their maintenance process, and how their (future) vision on maintenance fits the Asset management concept. In stage C the key factors hindering the change process municipalities towards Asset management is projected against the theory on Asset management, and Change management. This stage can be described as an interaction between theory and practice. Insight is gained in the working of the municipality and the way they interact with these issues.

The results of stage C contains an answer on the sub-question V. Those factors refer to the identified factors from SQ IV.

*Results*

- SQ V: What are the fundamental causes of those factors?

***Stage D***

After a thorough analysis of the empirical data against the theory, a broad overview of the current state of the maintenance process within municipalities is revealed. Moreover, factors concerning the change process is developed and displayed in a model. The model should be used as a framework to identify the drawbacks and advantages to transition towards strategic AM in municipalities. The model sits between 'the current state of the maintenance process within municipalities', and 'the Asset management process for municipalities'.

There are two results in this stage. The first is a *Method of transition* for a municipality. It is a model, based on the previous SQ's that aims to smoothen the change process of municipalities towards AM. The second is the answer on sub-question VI. It is substantiated whether the method of transition is an adequate answer to SQ VI.

*Results*

- Method of transition

- SQ VI: How can we facilitate the transition process towards Asset management for municipalities?

***Stage B2***

After Stage D an iteration is made back to Stage B. The outcome of Stage D is validated with the interviewees to assure that the analysis made on the Municipality is in line with their interpretation. Moreover, the recommendations resulting from Stage D, are validated among a selected number of interviewees. This process is elaborated upon in Chapter 11 .

*Results*

- Validation

***Stage C2 and D2***

The input from the previous validation round is analyzed and processed in the final model.

***Stage E***
After an iteration process in which the results of D is validated with the municipalities the final chapter can be written. The objective of the last stage is to support the participating municipalities with their transition process. Next to these, an evaluation is made to determine whether or not the method is appropriate, and how it is best executed. In the end, the research question is answered. Figure 2-2 illustrates a condensed model for the research. In this model the driving idea behind the entire research is visualized.

*Results*

- RQ: How to contribute towards an effective Asset Management transition process for municipalities?

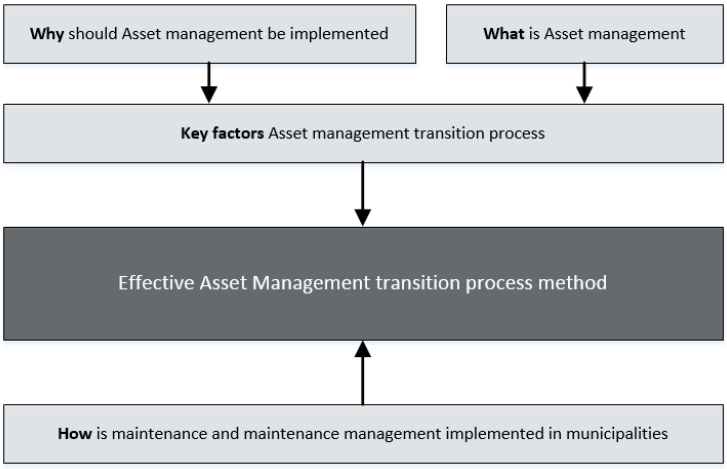



**Figure 2-2 Research schematics**

## 2.8 Research data

For each interview a transcript is made to assure that information is not lost in the process. Thereafter a qualitative analysis is made of each interview that assesses the municipality's implementation trajectory towards Asset management or 'Planned maintenance'. The line-of-sight model is used as an aid to identify the effectiveness (doelmatigheid) of the maintenance process.

A form of guidance on Asset management can be found in the publication of the NEN-ISO 55000 series issued in 2014. However, this guideline is structured to only prescribe the needs for organizations to implement AM rather than how it can be achieved. A consequence is that the organizations are still struggling with the question on how they can implement AM and moreover, what is actually meant by AM? Preliminary observation has shown that municipalities have their own implementation methods to improve their current maintenance processes. Their methods are projected against the line-of-sight model, and the practical and theoretical benefits and disadvantages are assessed among them. As it concerns a municipal organization, the way they handled the 'how' during their implementation is applicable for other municipal organisations as well.

# Chapter 3 **Asset management theory**

*Theoretical research on Asset management is extended in this section of the study. The results originating from Chapter 3 are used to answer sub-question I, entailing the cornerstones and characteristics of Asset management.*

*In contrary to § 1.2, the emphasis in this chapter is not on the line-of-sight within Asset management, but instead the focus lies on underpinning the core of the methodology, and forming a theoretical model against which the empirical results can be compared.*

*Sub-research questions (see Chapter 9 )*

*I. What are the cornerstones of Asset management?*

## 3.1 Chapter methodology

In this section the theory on Asset management is assessed. In addition to a general overview of AM, the chapter includes two main research ambitions. The first is to identify the *main purpose* of Asset management, so that it is clear why organizations are adopting this methodology, or how it could benefit them. The second ambition is to identify the *core processes* in AM. This knowledge is used to apprehend what an AM process is.

The main research strategy adopted to achieve the desired results is a **desk research**. Verschuren and Doorewaard (2007, p. 201) points out that this strategy relies on existing theories and literature, but new insight is created in the way the researcher reflects on this knowledge. Nevertheless, a desk research also has its limitations. For such The University of Queensland (2017) states that common pitfalls are the lack of a critical approach, unable to differentiate between relevant and irrelevant materials, relying on outdated literature, or assuming a "*parochial perspective*" indicating an unilateral use of sources. The reliability of datasets and statements made by the authors should be considered at all times. A mitigation strategy is to include various perspectives by using multiple 'diverse' sources. In the end, it is the responsibility of the researcher to judge how and which statements are used to reach the research ambitions of this chapter.

The first research ambition, main purpose of AM, is explored by identifying the International standard for AM, and by adopting a simple database search on Google Scholar, a search engine for academic papers. Through these means, a collection of relevant source material is identified, and various perspectives on Asset management is analyzed. Preliminary literature research in Chapter 1 has shown that *Value* is an important terminology within Asset management. Additional theory on value can be found in Appendix J, section II.

The second research ambition, core functions within the AM process, is answered by utilizing a simplified approach to the methodology developed by Frolov et al. (2010), that analyses the complexities of Asset management from a Business process modelling perspective. Herein a Business process is defined as "*a specific ordering of work activities across time and place…and clearly identified inputs and outputs"* (Lindsay, Downs, & Lunn, 2003, p. 3). In the context of this definition, activities are labelled as Asset management functions. In Frolov's research paper "*Identifying Core Functions of Asset Management*", he proposed a research framework consisting of a text mining approach, pattern identification, and assessment matrix to map the AM practice into appropriate levels. In this research only the highest abstraction level of AM is assessed as a mean to understand the Asset management process. In the end, depending on the used sources for the text mining stage, the core functions of AM are identified.

The answers gained in this chapter on Asset management are used to eventually identify the cornerstones of Asset management; Sub-research question I.

## 3.2 Introduction

Disciplinary integration (integrated management system approach) is a necessity for Asset management, whereas the various disciplines ranging from engineering, operational management, and information systems operate in unity towards a common goal (International Standards Organisation, 2014a, p. 15). It is therefore essential that the various departments and disciplines are able to work effectively towards a common goal. Moreover, according to Al-Turki, Ayar, Yilbas, and Sahin (2014, p. 5) the success of organizations and projects depend on competent maintenance of the assets. It shows that the success of an organization not only depend on its maintenance processes, but also on how it has structured its organization around their maintenance process.

To put the importance of maintenance in perspective, the expected expenditure for infrastructure in the Netherlands is estimated at a total amount of 5.8 billion euro's in 2016, of which 2 billion for construction, and 2.4 billion for the management and maintenance (Rijkswaterstaat, 2016, p. 6). This financial decomposition shows that a large proportion of the budget is reserved for maintaining assets, and thereby revealing its significance towards the total Life Cycle costs. Nevertheless, few public asset owners have a thorough understanding of their own asset network, and its effect on the overall success of their organization[6]. In recent times many organizations, including public authorities, have acknowledge the importance of improving their operations, and are researching various methods to do so[7]. Operational Excellence is one of the most important management buzzwords, indicating the execution of business processes that "*satisfies the customer demands, improves quality, generates higher yields, faster throughput, and less waste"* (Capgemini, 2006, p. 1). It represents a prevailing philosophy within organizations to keep improving. Within the maintenance sector, Asset management is one of the methodologies generating a lot of interest. It is claimed that conforming to AM will lead to operational excellence, through improvements in efficiency, and effectiveness (referring to International Standards Organisation (2014a, p. 5)). However, due to its theoretical emphasis, practitioners struggle with its implementation (§ 2.1). This brings into question; what is the main purpose of Asset management, and how does it change the current maintenance processes?

## 3.3 Defining Asset management

The term Asset management is partially defined in the introductory section of this report (§ 1.2). To summarize the definition specified in the NEN-ISO 55000, AM is the management of the (primary) assets to create value for an organization. The latter is achieved through translating the strategic objectives to asset related decisions and activities using a risk-based approach (International Standards Organisation, 2014a, p. 6). An approach for this alignment is the line-of-sight model (Figure 1-4) that aligns the decision making of maintenance activities with the goals of the organization. The theoretical founded approach here fore was developed by Huerne and Willems (2011), and is adopted as the backbone of AM in this research.

Asset management is defined in many ways among different industries, and even researchers within a particular discipline do not always adopt and agree with leading disciplinary definitions. New Asset management definitions are continuously created to fit the audience for whom the paper is written, or to fit the context of the research. In Appendix E a list of different AM

[6] Research of Rekenkamer, Randstedelijke Rekenkamer, Algemene Rekenkamer in Flevoland, Noord-Holland, Utrecht, Zuid-Holland, Groningen, Amsterdam, Breda, and Hoorn.
[7] Empirical research; Statement based on preliminary research (Appendix C)

interpretations are included that differ in technicality or context of the researcher's study. However, from a fundamental standpoint, the definitions are quite similar in meaning. They all regard Asset management from an engineering perspective with tangible assets. It describes the "*core role in life – both caring for, and making best sustainable use of infrastructure*" (Woodhouse, 2003, p. 2). This interpretation is the leading view on AM for physical assets, and in a sense overlaps with the definition used in the NEN-ISO 55000.

From a practical standpoint it can be argued that it is futile to stumble upon the technical variances in AM definitions. In the researchers opinion it is one of the key causes in ambiguity and lack of know-how of Asset management. Reyes-Picknell and Wittenberg (2016, p. 2) agrees in that the term AM "*is vague and requires definition for specific audiences*". When different definitions are created to fit specific audiences, different interpretations are the result. Y. C. Wijnia and Herder (2010, p. 5) goes even further and argues that theoretical definitions on AM are "*empty statements"* for practitioners, because they are described as a line of thought rather than as a decomposition of processes. In other words, we can assume that practitioners struggle with understanding the theoretical substance of Asset management, and its impact on their work activities[8]. To successfully explain the term in a practical sense, it is more important to define the practical implications of Asset Management rather than a pure theoretical. As long as researchers merely focus on the notion behind the methodology, the gap between theory and practice will remain.

## 3.4 Purpose of Asset management

It is commonly assumed that Asset management is merely the management of assets, or efficient maintenance by "*asset stripping*" (Woodhouse, 2003, p. 1). Instead, it is a part of an overall asset management framework. Asset management is an enterprise approach to align the maintenance activities (asset-related spending) to the strategic corporate objectives (Hastings, 2014; International Standards Organisation, 2014a). It integrates a broader business process into the operational engineering solutions. With this mindset, decisions throughout the entire value chain (Asset owner to Service provider) are made in accordance with a single set of criteria. There is a comprehensive 'line-of-sight' that is utilized to reach the greatest organizational value within the available funds. Admittedly, this depiction of AM is difficult to imagine and to understand. Therefore, the purpose and functions of AM are listed in the following section.

To create an understanding of Asset management, an organization should be aware of the purpose of Asset management. R. E. Brown (2004) discusses that there is a fundamental difference between the goal of AM, and the result. Nevertheless, both are frequently wrongfully interpreted. For example, WCM Infra (2016, p. 2) mentioned four goals; increasing Reliability, Availability, Safety, and decreasing the Life Cycle costing. However, Brown mentioned that these are purely the results of AM, and not its main objective. To sum it up, there are various other methods available to improve reliability, availability etc. It is therefore understandable that practitioners do not recognize the direct added value of Asset management in comparison with other methodologies. According to R. E. Brown (2010, p. 306) on AM, and shared by the researcher, the purpose of AM is described as follows (R. E. Brown, 2010, p. 306):

- Company-wide strategy to balance the costs, risks, and performance
- The alignment of the corporate objectives with the asset-related spending
- Decision making based on a rigorous and data-driven process

The Asset management engineering perspective calls for a sustainable usage of assets that continues to provide value for an organization (see definition given by Woodhouse (2003, p. 2)).

[8] Validated by Interviewee 8-74 (Appendix C, section I).

The stated objectives of AM show that this is feasible with a company-wide strategy, alignment of corporate objectives, and data-driven decision making. In other words, it is a value-based rationale that regards an innovative way of thinking that improves value, rather than doing only what is necessary (more on Value in Appendix J, section II).

## 3.5 Asset management core functions

A maintenance management process is often seen as a straightforward process that resembles the event-oriented view by Sterman (2001, p. 13) (Figure 3-1). In this view the problem that is to be solved is the gap between the goal and the current situation. However, in reality our interventions influences the system, and are not independent of each other. In other words, our actions influences the present and future situations, and might lead to unanticipated side effects. Therefore, the decision making process should include feedback loops that merges the world of the decisions makers (stakeholders) and the impacted environment. To integrate the stakeholders into a model, a socio-technical viewpoint should be adopted. By focussing on both the physical assets and soft factors (i.e. stakeholders), the decision makers are able to learn how their decisions and strategies could impact future situations. Those sociotechnical dynamics stands at the heart of an Asset management methodology.


**Figure 3-1 Event-Oriented View of the World (Sterman, 2001, p. 13)**

To understand the implication of Asset management in an (municipal) organization, the most important aspects within AM are assessed. The core functions of the Asset management process are identified with the aid of the methodology proposed by Frolov et al. (2010)[9].The approach is visualized in a flowchart format as shown in Figure 3-2. It originally included four inputs required for the methodology, namely; (1) Industry type classification, (2) Terminology identification, (3) Level classification, and (4) Matrix templates. However, these are omitted as they are already partially covered in previous chapters, is not used in the analysis, or an adapted form is used by the researcher.

***Identification of Relevant Documentation***

This process step concerns the scoping of literature based on the industry context. There are various kinds of industries practicing the AM methodology, with each their own guidelines and documentation. However, due to the lack of a coherent Asset management guideline for Local government authorities, industry-wide documentation and standards of Asset management for physical assets are considered. This coincides with the scope of the NEN-ISO 55000 standard.

A selection of literature is made, based on its inclusion and identification of AM activities (functions);

Y. Wijnia and de Croon (2015); described a reference model of the asset management system for infrastructures.

United Energy (2015); developed an asset management framework that aligns the activities and the documentation.

[9] Note the core functions as mentioned in this part is not the same as the functions (functionalities) stated in § 1.3 and **Error! Reference source not found.**.

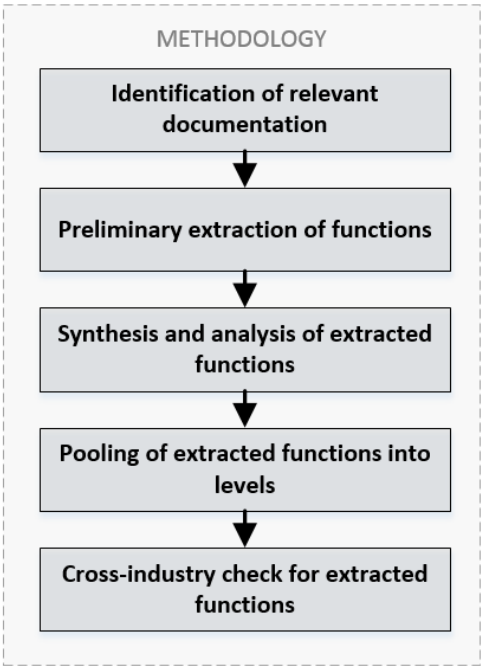



**Figure 3-2 AM Core Functions Methodology (Frolov, Ma, Sun, & Bandara, 2010, p. 22)**

Hastings (2014); his literature is regarded as an introduction to the general principles of physical asset management.

International Standards Organisation (2014a) (ISO-NEN 55000); an international standard for the Asset management of physical assets. Highly regarded in the infrastructural sector.

IAM (2014); A not-for-profit organization focused on advancing the science, practice, and discipline of Asset management.

AAMCoG (2012); a guide reflecting the advances in Asset management. Developed with assistance of the Cooperative Research Centre for Infrastructure and Engineering Asset Management (CIEAM).

R. E. Brown (2010); application of business theory in engineering disciplines. Extra attention is devoted to Asset management.

Frolov et al. (2010); the researchers of the Core functions methodology. In their provided example, they included a number of AM core functions.

### *Preliminary Extraction of Functions*

There are multiple methods to extract Asset management functions from the documentation. Frolov et al. (2010, p. 26) referred to "*text mining*" as the preferred approach, as it can be applied to extract patterns from the "*natural language*". In most cases text mining rely on computers for processing data. However, computers generally cannot coop with the ambiguities that are prevalent in the natural language. Mengel, Bandara, Sun, Frolov, and Ma (2010, p. 3) described the occurrence of "*lexical ambiguities*" (words being a verb or a noun), *"syntactic ambiguities*" (parsing of sentence), and "*semantic ambiguities*" (meaning of sentence), as difficulties in writing computers struggle with. Therefore, a manual text mining approach is opted. It is performed by scanning the literature on the appearance of certain keywords and its alternative expressions. Knowingly, the quality of the function extraction depends on the judgement of the researcher.

To document the text mining step, Frolov et al. (2010, p. 25) provided a matrix template for use. However, for this stage of the research the required input of their template is too extensive. In addition, in the researcher's view, the intended reason to adopt this methodology does not correspond with the way data is visualized in such template. Instead, here the findings are documented in a customized matrix table which shows the occurrence of certain criteria in the literature (Appendix D). Using this methodology core functions are identified based on the sum of the occurrences. The result of this stage is presented in the matrix table in Appendix D. Admittedly, the stated functions (activities) are documented on a high abstraction level, but the data is still useable for the identification of important functions in Asset management.

The matrix table in Appendix D incorporates 40 distinct functions extracted from the aforementioned literature. The functions are ranked based on the occurrence of the key terminology or its alternate definition. The top functions are interpreted as an AM core function for physical assets (Figure 3-3).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Corporate strategy | x | x | x | x | x | x | x | x | | 8 |
| 2 | Capital planning (CAPEX) | x | x | x | x | x | x | x | x | | 8 |
| 3 | Maintenance planning/ policy | x | x | x | x | x | x | x | x | | 8 |
| 4 | Performance evaluation | x | x | x | x | x | | x | x | | 7 |
| 5 | Managing through audit/ | x | x | x | x | x | x | x | x | | 8 |
| 6 | Operations planning | x | x | | x | x | x | x | x | | 7 |
| 7 | Strategic planning | x | x | x | x | x | x | x | | | 7 |
| 8 | Data management | x | x | x | x | x | x | | | | 6 |
| 9 | Risk management | x | | x | x | x | x | x | | | 6 |
| 10 | System- and software engineering | x | x | x | x | x | x | | | | 6 |
| 11 | Configuration management | x | x | x | x | x | x | | | | 6 |
| 12 | Capability management/ | x | x | x | x | x | x | | | | 6 |
| 13 | Business values | x | x | | x | x | x | x | | | 6 |
| 14 | Budgeting (OPEX) | x | | x | x | x | x | x | | | 6 |

**Figure 3-3 Core AM functions (in reference to Appendix D)**

### *Synthesis and Analysis of Extracted Functions*

This process step regards an analysis on the found functions based on its similarities in definition. Frolov et al. (2010, p. 26) refers to this as a "*taxonomy approach*", which attempts to group all possible naming's and descriptions of a terminology. The table in Appendix D, shows which keywords are linked to its alternate descriptions. The results are incorporated in the matrix table of Appendix D.

### *Pooling of Extracted Functions into Levels*

What is meant by levels, is the level of abstraction of the process. The functions are categorized (pooled together), based on the importance of the function in the AM process, and its impact on others. The top-level process is level 1, and the subsequent sub-functions are designated as level 2 etc.

By evaluating the identified core functions in Figure 3-3, we are able to reason that the majority of the functions can be regarded as a level 1 function. In order to identify the level 2 functions, more emphasis should be put on the industry context, as it focuses more on the 'how' question than a level 1 top function could. However, in the context of local governments, this assessment can only be done at the end of this research (based on empirical data).

In addition to the levels, AM can also be divided based on the hierarchical functions (Figure 1-2):

- Asset owner: Strategic policy goals
- Asset manager: Programming and Planning
- Service provider: Execution and Data reporting

The functional separation is used as a support to project the core functions of Asset management against the Asset management process chain (Figure 3-4). In the model a distinction is made between the Corporate management processes, AM supporting processes and the AM Core functions.

The model is developed at a high abstraction level, but in a way it visualizes the characteristics of the Asset management concept.

### *Cross-industry check for Extracted Functions*

As mentioned before, the analysis on Asset management is performed industry wide as reliable documentation for merely the Local government industry is scarce. However, an analysis specifically on local governments is done in a further section of the report using empirical data from the interviews.

## 3.6 Asset management core function model

The identified core functions of Asset management are visualized in Figure 3-4. The Asset management functions are grouped as *Management process*, *Supporting process*, and *Core function.* The *Management process* regards functions that operate at the core of an organization, or is about the organization itself. The Asset management process is subsequently decomposed in a number of *Supporting processes*. Herein the key process is the *Managing of assets*, which is further divided based on the hierarchical roles, into Asset management core functions. An important notion is the inclusion of the supporting function *Configuration management* in the AM core function model. Fundamentally, data gathered in an Asset management system does not provide sufficient information regarding the impact of assets on the delivery of a service. There is a need for some form of Configuration management that manages and controls the relationship between the asset components and the required services. Configuration management consists of four primary functions "*identification*", "*change control*", "*status accounting*", and "*auditing*" (Boycan et al., 2005, p. 10). These four primary functions are vital for an effective AM process.

The identified AM core functions give a broad understanding of Asset management. It revolves around the NEN-ISO 55000 definition to create and improve value for the organization by supporting the AM process consisting of a strong linkage between strategic, tactical, and operational activities. In an attempt to clarify the core function model, the Asset management process model developed by Van Houten and Zhang (2010, p. 57) is incorporated in Figure 3-4. It represents an Asset management flowchart of the decision making process in the infrastructure industry. The core function model represents *what* Asset management should include, and the AM process flowchart shows *how* (at a high abstraction level) it could be incorporated in the infrastructure industry.

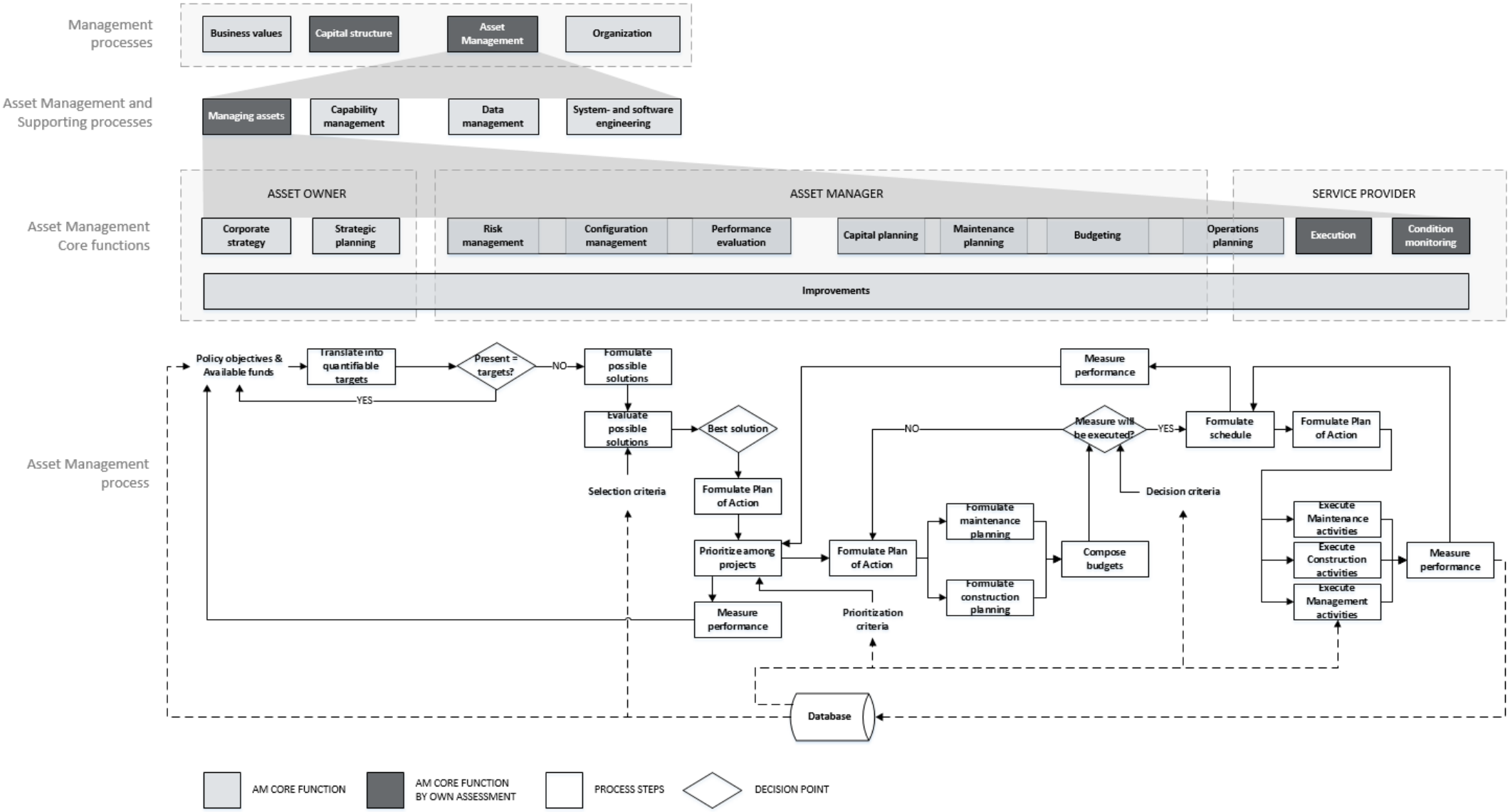



**Figure 3-4 AM core functions in relation to the AM process chain. AM process adapted from (Van Houten & Zhang, 2010, p. 57)**

## 3.7 Summary

The theory of Asset management was assessed based on various researches, literature, and research methodologies. A summarized answer is provided focusing on the purpose of Asset management and the main components within the Asset management process.

Concentrating on the main goal of Asset management enables the interested party to envision a clear starting and focus point for Asset management implementation. The Asset management engineering perspective calls for a sustainable usage of assets that continues to provide value for an organization. R. E. Brown (2010, p. 306) argued that there are three main purposes to AM; (1) balance the costs, risk, and performance with a company-wide strategy, (2) align the corporate objectives with the asset-related spending, and (3) making decisions based on a rigorous and data-driven process. Committing to these three points enables the organization to increase the asset reliability, availability, safety, and decreases asset Life Cycle costing.

Figure 3-4 includes the most critical components of Asset management; the core functions. The core functions as referred to in this thesis are the critical process components within the Asset management process. These are processes that are required, but could differ in execution between the organizations. In addition a flowchart, developed by Van Houten and Zhang (2010) is incorporated that reveals a general decision making process for AM in the infrastructure sector. Again, each organization needs to understand that an AM process is unique and should be tailored towards their processes and organization. Nevertheless, the model shows that there is an incremental approach within Asset management. Each decision is based on substantiated data. It is the fundamental thought behind the line-of-sight terminology (referring to Chapter 1 ).

The identified core functions (industry-wide) are:

*Managing processes*: Business values, (Organization, Capital structure etc.)
*Supporting processes*: Capability management, Data management, System- and software engineering
*Core functions*: Corporate strategy, Strategic planning, Risk management, Configuration management, Performance evaluation, Capital planning, Maintenance planning, Budgeting, Operations planning, Execution, Condition monitoring

The identified core functions and the Asset management process model show that an efficient AM system should at least include the following:

- A form of Data management and support system
- An integrated management process and program regarding (1) Development, (2) Maintenance, (3) Review process, (4) Performance evaluation, (5) Finance
- Documented processes and standardized documentation
- Substantiated decision making process originating from values and data (past, present, future)

# Chapter 4 **Organizational impact of Asset management**

*The previous chapter outlined the theory on Asset management. In this section the impact of Asset management from an organizational, and individual perspective is assessed. The results from this chapter combined with Chapter 3 are used to answer sub-question I.*

*Sub-research questions (see Chapter 9 )*

*I. What are the cornerstones of Asset management?*

## 4.1 Chapter methodology

Asset management is a company-wide strategy (R. E. Brown, 2010, p. 306). It is therefore assumed that implementing the methodology impacts an organization in several ways. The impact of AM on an organization is assessed, and used as an intermediate step towards the creation of an Asset management change process, which will be outlined in Chapter 5 . Insight in the impact of Asset management on an organization could provide us information to what extent the organization is affected during AM implementation. With this in mind a transition process can be evaluated and key factors can be derived.

Following the same research strategy as the previous chapter, this chapter revolves around a **desk research** approach. The impact of AM on an organization is determined based on an impact framework that assesses how the core functions identified in Chapter 3 effects an organization. Based on the works of CSIRO (2015) and (Grant, 1991) the impact is grouped in the master categories Economic impact, External impact, and Social impact. Furthermore an assessment is made whether the Tangible, Intangible, or Human resources are effected. Additional information on the impact framework is appended in Appendix J, section VI.

The conclusions that are drawn from this chapter influences the key factors of change in maintenance within municipalities.

## 4.2 Introduction

Organizations are continuously adapting and altering their organizational structures, processes and to some extent their culture in an attempt to make their current processes more efficient and to adapt to the changing customer requirements (Balogun and Hope Hailey cited in Carlon, Downs, Pieterse, Caniëls, and Homan (2012, p. 798)). However Kirsh (2000, p. 19) stated that a change in environment and work process could lead to a 'cognitive overload' due to "*too much information supply, too much information demand*" in combination with role ambiguities, and conflicts. Burns and Stalker (2000, p. 44) mentioned that in contrast to a *"mechanistic organization system*", which refers to an internal organization characterized by a clear hierarchy, working behaviors governed by fixed instructions, and centralized decision-making, an *"organic system*" is more flexible with an unclear hierarchy, undocumented rules and procedures, and decentralized decision-making process. Organizations strive for more flexibility (organic system) as the structure allows for a better adaptation to change, but this shift is at the expense of individual security and career prospects (Hayes, 2014, p. 8).

Adopting a new methodology on a company-wide level has effect on the internal organizational structure, the business expectations, but also on the behavior of people. The extent to which Asset management effects the organization involves an analysis on the organizational impact. By portraying the organizational impact in a framework consisting of a categorization of impact,

provides us a mean to analyze the degree to which AM impedes the capability of an organization to gain a competitive advantage.

## 4.3 Impact evaluation

Impact is very broad and could be interpreted differently based on the industry context. While some forms of impact can be addressed quantitatively, such as financial impact, many others has a sociotechnical undertone and can only be evaluated qualitatively. Mohr (1995, p. 1) describes *impact* as the extent to which*"…the activities or effort involved in a program…relates to…any outcome of that program as the relation between a cause and its effect"*. Evaluating the impact is not an exact science, however there exists an academic approach to conduct the study. It entails a multi-year approach under the supervision of a researcher with a control group familiar with the concept of the study subject. Moreover it's time-consuming, and requires large amount of funds. Therefore, many researchers have opted for a cost-efficient approach for impact evaluation that measures the leading indicators, such as activities or output, as an alternative to control groups (Saltuk & Idrissi, 2015, p. 8). In this research a straightforward approach is adopted to assess the impact of Asset management in an organization. By identifying how implementing certain core functions of Asset management has effect on the organization a general 'impact feel' can be shown. These core functions are divided based on the core function model in the categories *Strategic level, Tactical level, Operational level,* and *Integration and Implementation* (Appendix F).

### *4.3.1 Impact identification*

The impact analysis in Appendix F is divided into four categories *Strategic level, Tactical level, Strategic level,* and *Integration and Implementation*. In each category the corresponding core function is used to determine the impact. It has been organized as follows:

- Relevant research papers are identified using the core function as search term. The impact factors found in the studies are listed. The focus was on determining the positive effects and motivations.
- The listed impact factors are specified in an impact category; *Economic impact, External impact,* or *Social impact.* Moreover, the applicable resources affected by the impact are included: *Tangible, Intangible* or *Human*.

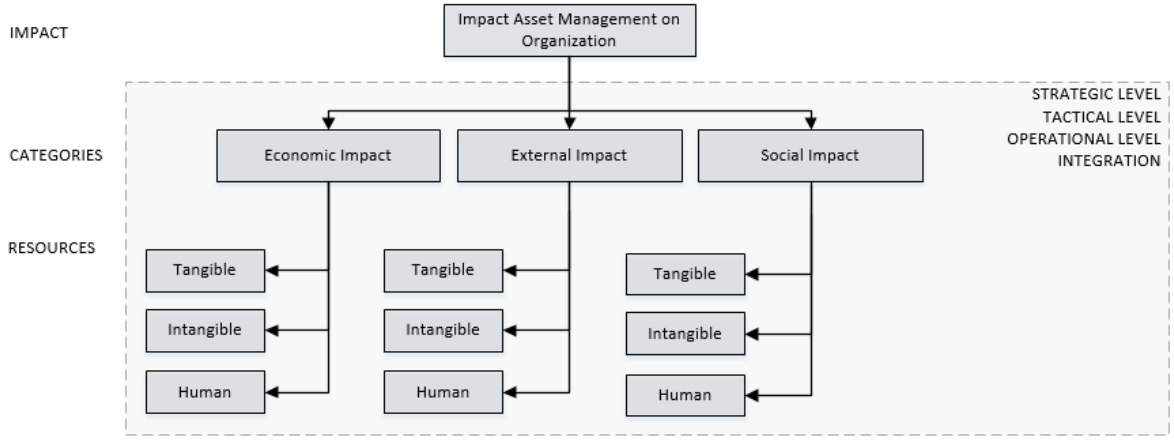



**Figure 4-1 Overview impact analysis Asset management**

The followed process is visualized in Figure 4-1. However, it must be noted that these identified impact factors are on a high abstraction level. A more detailed impact factor analysis is not executed, as this analysis is used to support the development of a transition process for municipalities in general towards Asset management. The core functions indicate what is required, and the impact factors show how the organization is affected by its implementation.

## 4.4 Impact analysis

The results of the impact analysis (Appendix F) are outlined in this section.

***Impact Asset management on a strategic level***

The core functions on the strategic level includes *Corporate strategy* and *Strategic planning*. A summarized list of strategic impacts are mentioned below:

| Strategic impacts | Research paper |
|---|---|
| Improves business focus | (Johnson et al. 2008, Wijetunge et al. 2014) |
| Improves allocation of resources | (Johnson et al. 2008, Wijetunge et al. 2014, Steiner 2010) |
| Focuses organizational capability | (Johnson et al. 2008, Wijetunge et al. 2014, Steiner 2010) |
| Structures organization for success | (Johnson et al. 2008, Bowman et al. 2001, Steiner 2010) |
| Increases competitive advantage | (Bowman et al. 2001, Steiner 2010) |
| Clear role responsibilities | (Johnson et al. 2008, Wijetunge et al. 2014) |
| Establishes clear vision | (Johnson et al. 2008, Wijetunge et al. 2014) |

**Table 4-1 Strategic impact (referring to Appendix F)**

The impact categories most affected by the core functions on a strategic level are *Economic impact-intangible* and *External impact-intangible* (Table 13-1). It affects how the organization performs competitively, and how the focus of the organization is sculpted around producing and accomplishing of what is important for them (value). It is important to note that neither of these are tangible, but in an extent do have great consequences on how tangible resources are used.

The impact study has shown that incorporating the functions on a strategic level requires changes in the structure of the organization, cultural changes, but also commitment of the employees. Restructuring their work processes, and responsibilities to align with the business focus will result in an improved organizational control, and improves the communication between employees as they are aware what the responsibilities are and what input he could request. Moreover, this also facilitates the communication towards external parties, as the needs and expectancies of stakeholders are taken into account.

***Impact Asset management on a tactical level***

The core functions on the tactical level includes *Risk management, Configuration management, Performance evaluation, Capital planning, Maintenance planning,* and *Budgeting.* A summarized list of tactical impacts are mentioned below:

| Tactical impacts | Research paper |
|---|---|
| Minimize negative impact on performance (time, cost, quality, safety, sustainability) | (Gitau 2015, Tekavčič et al. 2008, Dart 1990, Micheli et al. 2010, Allen et al. 2014, Rivers 2013) |
| Identify opportunities to mitigate risks<br>Reduce agency costs | (Gitau 2015, Tekavčič et al. 2008, Micheli et al. 2010, Rivers 2013, Gupta 2014) |
| Ensure integrity assets | (Tekavčič et al. 2008, Dart 1990) |
| Enable team to develop and maintain assets | (Dart 1990) |
| Selecting alternatives driven by data and events | (Gitau 2015, Dart 1990, Lapouchnian et al 2007, Maug et al. 1995, GAO 2007) |
| Align behaviors and attitudes | (Micheli et al. 2010, Transport for NSM 2015) |
| Motivating employees at all levels | (Micheli et al. 2010) |

| | |
|---|---|
| Clarify how capital relates to achieving the goals and objectives (strategic linkage) | (Tekavčič et al. 2008, Dart 1990, Lapouchnian et al 2007, GAO 2007) |
| Balancing the existing assets and new investments | (Dart 1990, GAO 2007) |
| Focus attention on organizational goals, needs and financial capabilities | (Tekavčič et al. 2008, Allen et al. 2014) |
| Determining service level | (Gitau 2015) |
| Opportunity integration of various departments | (Allen et al. 2014, Transport for NSM 2015, Rivers 2013) |
| Making bottle-necks in process transparent | (Gupta 2014) |

**Table 4-2 Tactical impact (referring to Appendix F)**

The impact categories most affected by the core functions on a tactical level are both *Economic impact-intangible* and *Economic impact-tangible.* Important component is aligning the resources both tangible (costs, assets), and intangible (human capital) with the strategic objectives. In addition the majority of efficiency measures (tangible, intangible) are performed on the tactical level; balancing costs and performance, and the focus on the organizational goals.

The impact analysis on the tactical level shows that the emphasis lies on the decision making process. The asset manager has to ensure the integrity of the assets by reducing problems and inefficiencies. He has to align the behaviors of both the system as employees to meet the objectives set out at the strategic level.

### *Impact Asset management on an operational level*

The core functions on the operational level includes *Operational planning, Execution,* and *Condition monitoring*. A summarized list of operational impacts are mentioned below:

- Assessing personnel capabilities and commission work
- Reviewing and estimate equipment need
- Provide necessary detail of strategy implementation
- Provide confidence to deliver results
- Set out Why, What and How the results are delivered
- Enable improvement by evaluation
- Demonstrating value for money
- Enables decision making based on substantive and corroborated diagnostic information
- Both proactive as predictive approach
- Measures system's input/output relationship
- Enables detection of failure before it occurs

| **Operational impacts** | **Research paper** |
|---|---|
| Assessing personnel capabilities and commission work | (Gaskill et al. 1994) |
| Reviewing and estimate equipment need | (Gaskill et al. 1994, RAO 1996) |
| Provide necessary detail of strategy implementation | (Gaskill et al. 1994, DFID 2010) |
| Provide confidence to deliver results | (DFID 2010, May et al 2015) |
| Set out Why, What and How the results are delivered | (DFID 2010) |
| Enable improvement by evaluation | (DFID 2010) |
| Demonstrating value for money | (DFID 2010) |
| Enables decision making based on substantive and corroborated diagnostic information | (RAO 1996) |
| Both proactive as predictive approach | (RAO 1996) |
| Measures system's input/output relationship | (RAO 1996) |
| Enables detection of failure before it occurs | (RAO 1996, May et al 2015) |

**Table 4-3 Operational impact (referring to Appendix F)**

The impact categories most affected by the core functions on an operational level are both *Economic impact-intangible* and *Economic impact-tangible* (Table 13-1). At this stage resources are mobilized for maintenance. However, as monitoring is an important component within the operational level, knowledge is gained which is passed back to the other levels.

### *Impact Asset management Integration and implementation*

The core functions included at this level are the *Management and supporting functions* mentioned in Figure 3-4. It covers *Capability management, Data management, System- and software engineering,* and the *Implementation* of Asset management. A summarized list of the integration impacts are mentioned below:

| Integration and Implementation impacts | Research paper |
|---|---|
| Improve organizations 'flexibility' | (Birkinshaw et al. 2000, Fernholz et al. 2007, Schreuder 2015) |
| Enable the management of internal and external flow of information | (Birkinshaw et al. 2000, Loshin 2012) |
| Understanding how value is perceived from those capabilities | (Birkinshaw et al. 2000, Morgan 2005) |
| Improve integration of knowledge | (Birkinshaw et al. 2000, Grant 1996, Loshin 2012) |
| Decision process that permits integration of specialized knowledge throughout whole organization | |
| Greater effectiveness organization | (Birkinshaw et al. 2000, Grant 1996, Goodhue et al. 1992, Zokaei et al. 2010, Morgan 2005, Fernholz et al. 2007) |
| Increase ability to collect, share and aggregate information | (Goodhue et al. 1992, Loshin 2012, Fernholz et al. 2007) |
| Improve communication and coordination | (Birkinshaw et al. 2000, Goodhue et al. 1992, Loshin 2012) |
| Empowers the engagement of employees | (Zokaei et al. 2010, Schreuder 2015) |
| Identify key relationships | (Goodhue et al. 1992, Loshin 2012, Zokaei et al. 2010, Morgan 2005) |
| Connecting vision, policy, and plans | (Morgan 2005, Schreuder 2015) |
| Improved management confidence | (Schreuder 2015) |
| Improved reputation | (Fernholz et al. 2007) |

**Table 4-4 Integration and implementation impact (referring to Appendix F)**

The Integration and implementation stage is a level that regards the integration of all processes and components mentioned before. Fundamentally it is the essence of the Asset management process.

By using Asset management the firm is able to focus their maintenance activities based on the strategic objectives, and expectations of the stakeholders. Table 13-1 shows that the Asset management mindset (integration) along the whole organization has the biggest impact at the social level (*Social impact – Human*). It is about communication, knowledge sharing, and organizing the firm with AM in mind. Therefore it is arguable that the main focus of Asset management should be initially the social component. The core functions that need to be in place at the strategic, tactical, and operational level are there merely to support the implementation of AM. Only with strong fundamental (organization), transitioning towards AM will be successful.

| | Strategic Level | Tactical Level | Operational Level | Integration |
|---|---|---|---|---|
| Economic impact - Intangible | 33% | 32% | 40% | 40% |
| Economic impact – Tangible | 17% | 26% | 40% | 0% |
| External impact – Intangible | 33% | 11% | 0% | 20% |
| External impact – Tangible | 0% | 11% | 0% | 0% |
| Social impact - Human | 17% | 21% | 20% | **40%** |

**Table 4-1 Fraction of Impact categories per Level (referring to Appendix F)**

***Negative impact***

The impact factors mentioned above emphasize the positive effects of AM. However, there also downsides to it, that are recognized by many authors, and practitioners. The reason these are mentioned separately is because the negative impact are in essence comparable for all levels.

Asset management is a methodology of which the benefits are usually only perceived when it is implemented correctly. During the implementation process adverse effects could even be identified that were not present in the old situation. Downsides are usually time, and cost related as it requires huge upfront costs, resources and a lot of planning. Implementing Asset management is actually a change management process, as the organization needs to *change* and needs to follow different processes, or needs to reorganize. A benchmark study in 2014 on best practices in change management conducted by Prosci (2014, p. 6) showed that the most frequent cost components for change management were "*resource costs, training costs, and communication costs*".

Another negative impact that can be identified is that it might lead to friction within the organization as employees are fearful for change. This is seen as resistance to change, and could encourage perverse behaviors, and lead to large scale dissatisfaction and lack of motivation when the implementation is mishandled (Prosci, 2014, p. 4).

Moreover, not understanding why certain processes or systems are embedded could lead to a misunderstanding between employees and departments. As such the employees could perceive an increase in control by their supervisors that could lead to further segregation. However, not disregarding the negative impacts we should note that Asset management will lower the amount of unplanned work. Wireman (1989) mentioned that planned work consumes almost a third of the resources in contrast to unplanned work. The negative impacts of Asset management are valid, but these can be mitigated with a strong transition process that focusses on the social component of AM.

## 4.5 Summary

An organization aims to improve their competitive advantage by maintaining their assets more efficient and effective. Using Asset management as a companywide strategy leads to improved business focus whereas the resource allocation follows the objectives set out at the strategic level. Implementing Asset management also improves the structure of the organization as it is shaped to support the new communication channels, responsibilities, and decision making process. Besides the organizational influences, AM also improves asset knowledge with a thorough data system supporting the decision making process leading to an improved prioritization and selection of necessary activities.

How Asset management impacts an organization is researched by assessing the impact of the core functions on three master categories: *Economic impact, External impact* and *Social impact.* Moreover, it is stated whether it affects the *tangible, intangible* or *human resources.* On a strategic to operational level the impact is usually economic and external. However, a fourth level "Integration and implementation" is also assessed. This level is fundamental within AM, as it is about integrating the processes, coping with the employees and organization, and having a substantiated line-of-sight. It showed that the social component is vital herein. It can therefore be argued that in Asset management implementation more emphasis should be put on the aligning the social construct, instead of merely focusing on the supporting core. How the transition towards AM is embedded in the organization, how committed the employees are, and how the employees perceive the values of it determines whether AM impacts the organization positively. When the transition is not well facilitated, the benefits are apparent much later, and the improved effectiveness and efficiencies of the process are affected in a lesser extent.

The challenge in the transition is thus not on the implementation of the system, but in gathering support, commitment, and capability of the employees. The transition period should be managed to convey the Asset management message. With such in place, the systems (and core functions) follows.

# Chapter 5 **Transition towards Asset Management**

*In this section the impact of the change process is central. The change management theory is assessed, and vital factors during the transition process are identified.*

*Sub-research questions (see Chapter 9 )*

*II. What are the key factors required for the Asset Management transition process?*

## 5.1 Chapter methodology

Improving a maintenance process is a continuous cycle of implementing change. This could range from a large organizational wide change process to small improvements. However, in a sense these change processes follow a similar pattern whereas the success of that change relies on a number of key success factors. These key factors are retrieved from various literature on Change management.

As the research question partially regards the identification of key components to aid the change process, these knowledge gained in this chapter is vital for drawing the final conclusion. This chapter is part of the theoretical framework and therefore a **desk research** approach is opted.

## 5.2 Introduction

In § 4.2 it was stated that organizations are continuously adapting by changing their internal structures, processes and culture. An increasing number of organizations transition towards an *"organic system*" as it is more flexible, and presumable give them the competitive edge in the current market (Burke, Lake, & Paine, 2008, p. 21). However, an organization wide transition towards Asset management is a strategic change that not only shifts the internal structures and processes, but also changes the cognitive nature of an organization. It has a profound effect on employees and induces a higher level of stress, and could lead to lower performances, commitment, and even affects the physical and psychological well-being of employees (Hayes, 2014, p. 8)

In 2013, the Economist Intelligence Unit (2013, p. 3) conducted a global survey among 587 senior executives and found that 61% struggled to bridge the gap between strategy implementation and the operational activities. Moreover, only a mere 56% of the strategic initiatives were seen as successful. Recognizing this trend in strategic change reinforces the sense to apply change management for Asset management implementation. Bovey and Hede (2001, p. 372) and other researchers mentioned that failure in corporate change programs were often attributed towards the resistance of the employees. Even though the technical elements of change is vital, the human elements often of equal importance shouldn´t be neglected. In the article *"Why do employees resist change",* Strebel (1996) conducted a study among 200 managers who admitted they had faced difficulties adapting to the rapidly changing market. The author concluded that the difficulties were corresponding with a common underlying cause in that the employees and managers viewed change differently. Both the employees as managers were aware that vision and leadership were important components in a successful change process. However, managers perceive change as an opportunity to improve the organization by aligning strategy with the operational activities. While on the other hand employees appreciate change in a lesser extent and saw it more as a *"disruptive and intrusive"* activity that affect the balance in the organization (Strebel, 1996, p. 1). In order to achieve successful change, the organization should acknowledge the importance of the individual. Smircich (as cited in Fiss and Zajac (2006, p. 1173)) stated that the "*success of strategic change will depend on…the*

*organization´s ability to convey the new mission and priorities to its many stakeholders*". Conveying a clear message towards the stakeholders, and also to its employees will accelerate the process from initial resistance to commitment.

As the introductory section has shown, a lot of research has been performed on the domain of change management, and organizational change. Based on those many researchers have isolated the importance of a cognitive stance as a key factor. In this chapter the most important aspects towards an organizational adoption of Asset management are identified.

## 5.3 Change management theory

The term change is defined as "*the process of transforming the manner in which an individual or organization acts from one set of behaviors to another"* (Leonard & McGuire, 2007, p. 46). Change can be implemented incrementally or radically, but irrespective of the chosen method change often requires employees to adopt new skillsets, and change their behaviors. Overall, change impacts an organization at four levels; the processes, systems, structure, and job responsibilities (Creasey, 2007, p. 2). For the need of change within an organization there are many triggers and motivations ranging from internal to external stimuli. When we approach change in an organization from a more structured perspective we could refer to it as change management. Creasey (2007, p. 3) defined change management as "*the process, tools and techniques to manage the people-side of change to achieve the required business outcome*". It is a business terminology that views the business transformation at a broader perspective as it focusses on the social side of change. It covers how people should be motivated, how change is accepted and eventually how to embrace it. However, there are many models and theories on change management that differ in the taken standpoint by the author. Often cited theories include *Lewin's Three-Step Change management theory*, extensions on Lewin's theory such as in *Lippit's Seven-Step Change management theory,* and emergent change models referring to *Pettigrew's Change management theory.* In order to create a better understanding of change management within organizations, these models are elaborated upon in this section.

### *5.3.1 Lewin's Three-Step model*

In Lewin's theory, organizations are seen as 'open systems' that consist of a set of interrelated sub-systems that operate in accordance to the requirements and needs of individuals and groups (Cameron & Green, 2015, p. 83). It is assumed that when an organization is designed around these social factors it is more likely there will be a healthy adaptive functioning of the system. This principle has formed the basis of Lewin Change theory in that change can only pursued when the driving forces behind change outweigh the resisting forces. Lewin (1951), proposed a Three-Step model to coop with organizational change.

The first step regards *unfreezing* the current situation, referring to analyzing and defining the initial start-state and the desired end-state, and take action to stimulate the driving forces and suppressing the restraining forces. Inducing the need and belief for change mitigates the individual's fear towards change. Robbins (as cited in Samuel (2013, p. 76)), listed a number of activities which can be used to support the unfreezing stage; *motivate participants, build trust and recognition, actively participate in problem recognition, and brainstorm sessions.*

The second step in the model is *moving* to a new state. In this step it is identified what exactly needs to be altered, and a resulting implementation strategy is formulated. Samuel (2013, p. 76) mentioned three actions that could support the moving stage: persuading employees that the current situation is undesirable and impose them to adopt a new perspective, collaborate to obtain new information, and align the views of the employees with powerful leaders supporting the change.

The third step focuses on sustaining the implemented change over time. Lewin's refers to it as *refreezing* the new state and balancing the driving and restraining forces in the organization. With this step in place the organization permanently adopts the new policies, standards, values and behaviors resulting from this change. It ensures that the employees and organization doesn't transition back to the start-state which it naturally tends to do. Samuel (2013, p. 77) suggested that both formal and informal policies and procedures could assist in refreezing the new state of an organization.

Lewin's Three-step model can be used as a tool to organizational change. Its strength lies in a collaborative definition of the start-state and end-state. With this in mind an organization is able, with support among its employees, to anticipate its next steps in the change process. Often this revolves around communicating the approach and motives to its key players, stimulating the driving forces, suppressing the restraining forces, and come up with a company-wide supported transition plan along with a timeframe the results needs to be reached. Lewin's model emphasizes the social-technical character of an organization in which proposed changes should work in union with the needs and wishes of its employees. This is in line with the intermediate conclusions of this research in which the transition towards Asset management should focus on the social side of change.

### *5.3.2 Lippitt's Seven-Step model*

Lewin's Three-Step model has shown the importance of the social side in change. However, Lippitt found that the Three-Step model was incomplete. Lippitt's Change theory is effectively an extension on Lewin's theory consisting of 7 steps. In this model the focus lies more on the "*role and the responsibility of the change leader*" (Lippitt, 1958; Vainalis, 2012, p. 6).

The unfreezing step has been divided into three stages. In *Phase 1* the problem is clarified and diagnosed. In *Phase 2* the motivation and capacity for change is assessed. In *Phase 3* the motivation and resources of the change agent is assessed. By acknowledging the conflicting interests of the client (organization) and change agent the goals and the motives behind change activities can be appreciated.

The Moving step is divided into two phases. In *Phase 4* a '*progressive change object'* is chosen. It refers to the selecting the plan of action, and change strategies. In *Phase 5* the change agent adopts an appropriate role. It is so that all key actors within the change process are aware of what can and cannot be expected of the agent. Stagl (2011) identified seven distinct change agent roles ranging from the counselor to the facilitator.

The Refreezing stage is divided in an additional two phases. In *Phase 6* the change is maintained by enforcing strong communication, evaluation and action, and collaboration. The last phase in Lippitt's model is *Phase 7*, and regards the termination of the relationship with the change agent. It is when the change is widely accepted and implemented throughout the organization.

Both Lippitt's and Lewin's model highlight the importance of defining the start-state and end-state of a change process. However, in Lippitt's model it is vital that the change process is supported by a leader that facilitates the successive transition towards the new state.

### *5.3.3 Pettigrew's model*

In the article "*Studying organizational change and development*", Pettigrew, Woodman, and Cameron (2001, p. 698) stated that early studies on organizational change gave purposeful insight in the drivers of change in a particular setting at a certain point of time. However, less focus was put on the "*spatial contextual factors*" leading to those happenings (Pettigrew et al.,

2001, p. 698). One of the derivative views on change, followed by Pettigrew among others, was an approach that explored the relation between (1) context, (2) content, and (3) process in time.

Pettigrew's Context/Content/Process model acknowledges the complexity of change, but also perceives change as having a purpose because it is undertaken in search of a competitive advantage and not merely as a tool to keep up with the external environment (Pettigrew et al., 2001). This model states that change should be analyzed based on three dimensions, and that success is the result of their interactions: context, content, and process.

Context refers to *where* the change takes place. It includes an organizations internal and external environment. Antwi and Kale (2014, p. 9) associated it with an organizations "*structure, culture, power distributions, skill base, resources, external influences, economic, legal, and social circumstances*".

Content refers to *what* kind of change takes place. It should be an intervention that would ultimately lead to an organizations competitive advantage. The change should increase the firms efficiency, or effectiveness, or both. Antwi and Kale (2014, p. 9) made an important acknowledgement in that the management has an important role into demonstrating leadership in order to "*conceptualize change and galvanize others in the organization towards achieving this vision of change*". Multiple academics thus refer to leadership as an important factor within the change process.

Process refers to *how* the change is implemented. Process is the last step in Pettegrew's model, and can only be successfully executed when one understands the begin, and end state of the organizational context, and how the measures proposed in the content stage would affect the internal and external environment

The usage of this model is shown as it reveals the vital factors in a change process for the change leader. The change leader has the most important role as he has to move the organization forwards, and should ensure that there is an understanding of an organizations environment, resources, change intentions, and overall coherence.

### *5.3.4 Assessing the Change management models*

The three mentioned models of change of a few of many. The chosen models each represent a different branch of change. However, fundamentally there are some differences, and commonalities. For example Lewin's model is a classic change model, and has been used and researched throughout the years. It is a straightforward approach with a fixed start goal, and a fixed end goal. However, the predominant method to implement change is by stimulating the driving forces, and suppressing the restraining forces. It is a theoretical sound approach, but fails in taking considerations into the employee's emotional states. It splits the organizations into two groups; the proponents, and opposition.

Lippit's extention on Lewin's model focuses more on the change agent. In his model the emphasis lies on the leader who has to dive into the motives of both the organization, and its employees. There is a more personal factor involved. By analyzing the driving forces and suppressing forces, and understanding is created for which the change process could be improved.

In the last model mentioned in this thesis, Pettigrew's model of change mentioned that a successful change is the result of a thorough interactive interplay between context, content, and process. The author also recognizes the importance of a change leader as one of the most vital factors in change. Not only to steer the change activities into the right direction, but also as the responsible role to set a clear vision and to clarify the goals, and implementation direction.

There is a strong commonality between the change models in that they all stress the importance of identifying the current state before the change (start state), and the desired state after the change process. Without, employees are unsure why there is a need for change, and it could pervert the process of change. Fundamentally, all models identify the people as important factors in change. The method to coop with it differ, however in the authors interpretation the change process should focus on the employees, and an organization should engage with a strong change leader who has his mind on the employees, and end goal (vision).

## 5.4 Success and failures in change towards Asset management

Municipalities are Asset owners of large physical assets. As VNG (2015, p. 13) mentioned their core objective is to add social value. Based on this statement we could argue that AM should be at the heart of a municipal organization. This sentiment is shared with Joubert (2016) who acknowledged that even though municipalities should have a sound AM foundation, they "*struggle with establishing an effective Asset management organization*". As the foremost reason behind this observation Joubert believes that AM requires change management to succeed.

The change management models, elaborated upon in this chapter, has shown that the emphasis of change is on how the organization and employees cope with the change process. The views of those authors fit into the conceptual model of change developed by Devi and Charan (2013, p. 93) (Figure 5-1).However, even though it is referred to as a model, it is actually a framework. It is particularly useful as it acts as a guide for organizations who wants to successfully initiate change. The root cause of change is represented by the external and internal drivers. The framework has three main components; "*Prepare for change*", "*Build Change Capacity*", and "*Change implementation*".

Important to acknowledge is the existence of "*Prepare for change*". As previously mentioned Bovey and Hede (2001, p. 372) and other researchers stated that failures in corporate programs were often the result of resistance of employees, and its failure to convey the new vision towards its many stakeholders. The importance of the first component is as such, that bypassing this phase towards the "*Change implementation"* is a guarantee for failure. In this phase the change leader has to deliver the message that change is needed, and by analyzing the *context* of the organization, and having a clear vision in place, employees will be more supportive.

The stage "*Change Implementation*" is often the stage were failures occur. Therefore a *process* needs to be established supported by an organizations infrastructure, and maybe more important culture in "*Build Change Capacity*". This is the stage where the core functions of Asset management are established. In coherence with the Asset management philosophy set out in the previous phase, the change leader is able to further implement an Asset management system supported by the strategic objectives.

Eventually the organization reaches the "*Change Implementation*" stage. Here the resources and control systems are put in place. Devi and Charan (2013, p. 93) mentioned that "*the key links between the strategic objectives and operational improvements are through the core processes, which need to be understood, measured, and improved*". Moreover, he argued that if the linkage is absent, the change is largely ineffective.

Visualizing this model as an aid for the change towards Asset management, the author argues that in order to successfully implement Asset management a lot of resources, and time should be put in the "*Prepare for change"* stage. It emphasizes the importance of a change leader having a pivotally role to guide the process taking into account the beliefs and values of the employees. This is also shown in Devi's statement who argued that change is ineffective when the linkage between the vision and operational improvements are absent. Disregarding the

change management process, the same is applicable for Asset management for which the most important aspect is the Asset management philosophy (line-of-sight), rather than delivering product and putting core functions in place mainly because they are required.

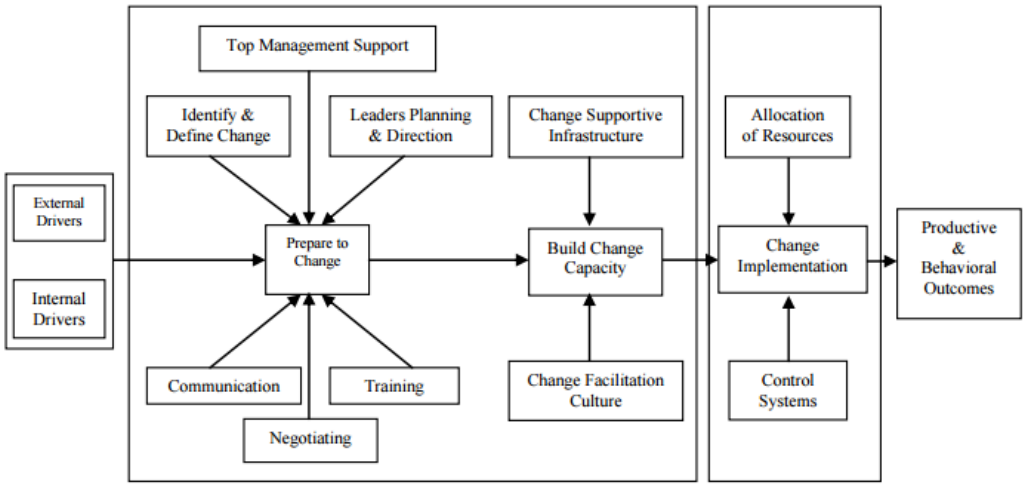



**Figure 5-1 Conceptual model of Change (Devi & Charan, 2013, p. 93)**

## 5.5 Leadership within the public sector

The change models by Lewit, Lippit, and Pettigrew, and the change framework by Devi address leadership as an important factor to success. However, in most change management literature there is no distinction made between the features of leaders in the private sector, and public sector.

From a traditional perspective, the private and public sector are very different. Koch (2005) outlined a number of differences such as the complex system of organizations in the public sector, their managers are under high levels of "*political scrutiny*", the end-users are the citizens, time horizon in which innovations need to pay off is an election period, and last a public organization has to deal with multiple performance indicators and targets while the private sector only has their return on investment. It refers to that leaders in the public sector has to comply with the wishes and needs of multiple stakeholders, objectives, and values. So it hampers the effectiveness of a measure, as it is usually a compromise. This occurs due to having more stakeholders in the public sector who are able to influence the project, such as legislators and the public (Wirick, 2011, p. 160). With more stakeholders, more of them need to be willing to compromise a solution as their desired outcome are usually not aligned, or could even be conflicting.

An empirical research, among 1500 public federal government leaders and 500 private sector business leader, on the differences in challenges between the private and public sector has shown that on a high abstraction level the differences are minimal (Ferguson, Ronayne, & Rybacki, 2014, p. 8). Nevertheless, there appear that there are more nuanced differences. Significant challenges private sector leaders' face more often are organizational growth, developing subordinates, and maintaining continuous improvement processes. While public sector leaders more often have to deal with problem subordinates (for unethical acts), motivating subordinates, and budget.

The context and challenges leaders in public and private sector deal with differ. However, from an organizational change perspective these differences are more visible in the *context* level, than in the *content* and *process* level referring back to Lewin's model. A change leader should

thus keep in mind that the implementation of change varies greatly between sectors, but also between organizations. Caton (2015, p. 71) even argued that public sectors are more motivated by job security and stability, while the main source of motivation for private sector employees were higher compensations.

In conclusion leaders in the public sector have to identify what motivates the employees, why they are opposing change, and how the new state of the organization will affect them, taking into account the differences in sector and organization. Considered that a public organization also has to deal with a political layer, bottom-up innovation is only allowed and encouraged when there is unrestricted trust between the politicians and agency (Couto, 2010, p. 931).

## 5.6 Summary

The change models of Lewin, Lepitt, and Pettigrew reveal a strong commonality in change models as they all stress the importance of identifying the current state before the change (start state), and the desired state after the change process. Without, employees are unsure why there is a need for change, and it could pervert the process of change. Fundamentally, all models identify the people as important factors in change. However, the method to coop with it differ. In the authors interpretation the change process should focus on the employees, and organizations should engage with a strong change leader who has his mind on the employees, and end goal (vision).

This argument is validated when the change framework of Devi is viewed. There is a strong emphasis on "*Prepare for change*", indicating that a change leader has a pivotally role guiding the process, as he has to take into account the beliefs and values of the employees and organization. This is also shown in Devi's statement who argued that change is ineffective when the linkage between the vision and operational improvements are absent.

In conclusion we could argue that transition in an organization, both private and public (having small nuanced differences), fits the change management framework (Figure 5-1). For the transition towards Asset management the framework could be elaborated upon with factors concerning which core functions are supportive for the Asset management philosophy.

# Chapter 6 **Maintenance in Municipalities**

*This chapter on maintenance within municipalities is used as a supportive chapter for the empirical research in Chapter 7 .*

*Sub-research questions (see Chapter 9 )*

*III. How is Maintenance organized within a Municipal organization?*

## 6.1 Chapter methodology

Following the research objective formulated in § 2.3, the current state of maintenance in the Dutch municipalities is analysed using elements of **desk research** and **case study** strategies.

The objective of this chapter is to identify how municipalities in the Netherlands cope with the maintenance of their assets. This is done on a high abstraction level as the researcher acknowledges that there are vast differences in the maintenance processes between the cities. However, the differences are used to create an overall maintenance understanding of Dutch municipalities. For such, interviews were conducted (Appendix C, section I) to identify what the municipalities find important in their maintenance process. These statements are supported with a theoretical basis. Therefore the following subjects are elaborated upon:

- Municipality structure (Empirical research)
- Municipal maintenance (Empirical research supported by theory)
- Line of sight (Empirical research supported by theory)

## 6.2 Introduction

The decentralisation policy implemented by the Cabinet throughout the whole governmental organization since 1980 has led to many changes in responsibilities for Dutch governments. Many tasks were delegated from the State of the Netherlands towards the provinces and municipalities. Starting 2014 and 2015 the responsibility shift towards the local governments was extended as they also gained the responsibilities over youth care, work and income, and healthcare of people with a long-term occupational disability and the elderly (Rijksoverheid, 2014). These decentralizations push the political, administrative, and financial options of municipalities leading to major implications. Municipalities struggle with tackling these ‘social’ issues alone. Therefore, they are gradually searching for integral cooperation with private parties by handing over the executing branch of tasks.

For both financial as strategic reasons effective management of municipal assets is gaining support. In this chapter a global analysis is performed on maintenance within the municipalities. Asset management is becoming increasingly important among the private, and public parties. . Fernholz and Fernholz (2007, p. 1) stated that an effective use of the municipals asset base is a vital factor contributing towards its revenues, and performance. In addition he estimated that the value of a municipalities fixed assets could constitute to 4 times its annual expenditures. Vulnerabilities in the cities assets could have a devastating effect on a municipals budget. In combination with the increasing responsibilities on other social areas, clashes in budgets will become an integral part.

Initial empiric research has revealed that the term Asset management leads to strong opinions among the interviewees[10]. Among all cities there are trends that maintenance is becoming more risk based, is heading towards maintenance prediction, and there is a strong recognition of improving the information flows, and data storage. However, not all municipalities refer the envisioned end goal as Asset management.

## 6.3 Municipal structure in practice

In appendix J, section VII the different Dutch municipal structures are briefly outlined. Based on empirical research a general model of the municipal structure is created in Figure 6-1[11]. This structure follows the management model with "*short vertical lines, and fewer Division managers*" when compared to a sector model (Aardema et al., 2009, p. 8).

The main legislative body is called the Municipal Council. They act on an electoral cycle of four years chosen by the citizens of the city. After each election the party with the majority of votes will form a majority coalition with other parties, and will largely determine the future policies of the municipality. Due to the manner of composition one could argue that the leading rationale (policy) in the Council is very short-term focused, as it varies after each election cycle (Interviewee 2-11A). The Council is tasked to verify whether the Executive board of Mayor and Alderman, carrying the responsibility over the Government administration, carry out the policies in a sufficient manner. In addition the council is also responsible for the budget allocation among all the departments. It is therefore vital that the Government administration is able to explicitly elaborate upon the required financial resources in an 'objective' way, or how the interviewees have denoted; having a 'good' story (Interviewee 2-22)[12].

The Executive board consisting of the mayor and aldermen are appointed by the coalition in the council. Each alderman represents a different policy sector and is tasked to report the progress to the Council. They are directly accountable for executing the policies set out by the Council. The Executive board is seen as the municipal government and is supported by the Municipal Secretary. The Secretary is the head of the Government administration, and has a mainly advisory function for the Executive board.

As the main subject in this research is the maintenance in municipalities, questions related to the composition of the municipal organization has led to similar answers among the interviewees. There is a strict division between the department responsible for maintenance (City management), and for the development of new projects, which could include large replacement tasks, in the City development.

[10] Empirical research; Statement based on preliminary research among a number of municipalities
[11] Statement based on Emperical research (appendix C, section I and question 1 in Appendix B, Section III)
[12] References made to interviews are hereafter referred to as "*interviewee number*"-"*section number*".

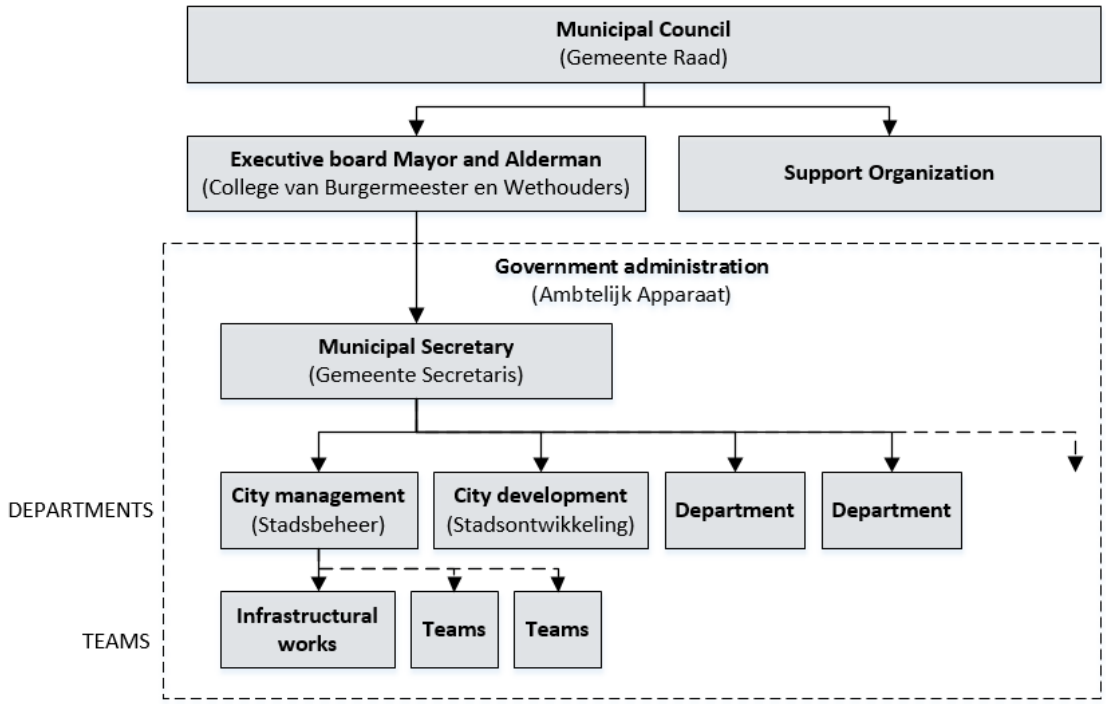



**Figure 6-1 Schematics organogram Dutch municipalities (source: Appendix C, section I, question 1)**

When we examine the Municipal organogram (Figure 6-1), in theory it fits the hierarchy levels of Asset management (Figure 1-2). The Council and Executive board act on a strategic level, and the Government administration on a tactical level. Depending on the city, the service provider (executing branch) are the market parties (Interviewee 5-49) or a part is outsourced to the market parties and the other is still operated internally (Interviewee 3.A-23,24). In such case the Governmental administration act both on a tactical as operational level.

The responsibilities for City management, and City development differ greatly whereas one municipality mentioned that the cooperation between both departments are nowadays merged into one department in an attempt to improve the partnership (Interviewee 5-47, interviewee 12-98). Another mentioned that there is still a dividing line between both departments (interviewee 2-9). The latter is the leading principle within municipalities whereas both departments often act independently.

However, the theoretical hierarchical distinction between asset owner, manager and service provider is not always followed by municipalities (Interviewee St.1, Interviewee St.3 [13]). Interviews with municipal employees on a strategic level showed that the division is comprehended, but not always formalized. Instead, employees throughout the whole organization take on mixed responsibilities that could signify both an Asset owner, manager or in some cases the service provider (see § 8.5). This is done purposely in order to encourage a proactive mindset, and to stimulate integration between departments and the organization as a whole (see § 8.5). Whether this actually leads to integration is not researched, but we can argue that there is a strong believe that a formalized hierarchical structure, in accordance to the AM theory, is not considered to be substantial by several municipalities. In conclusion, the municipalities recognize the theoretical distinct roles mentioned in the Asset management literature, but are not committed to reorganize their organization and reassign responsibilities to the employees using the trichotomy.

[13] Refers to the interviews in Appendix C, section II.

## 6.4 Municipal maintenance

Many municipalities have overdue maintenance, and are looking for new approaches to coop with this problem (CMS, 2016). Solutions are found in risk based maintenance, quality level focused maintenance, or Asset management (Interviewee 3.A, Interviewee 5, Interviewee 2). However, we can argue that they all converge to one process. Risk based maintenance is an importance process within AM, it involves demonstrating the actual performances of an asset and balancing the risks to determine adequate maintenance measures. Quality level focused maintenance (Beeldkwaliteit o.b.v. CROW) is a technical performance indicator that includes risk and performance components to determine the best maintenance measure (legal framework of maintenance, and the CROW levels in appendix J, section IX). In a sense municipalities use different terminology, but are interested in the same solution; Asset management. In this section an image is portrayed on how municipalities nowadays are managing their maintenance.

### *6.4.1 Changes in maintenance*

Taking into account the maintenance organization, municipalities are changing in two areas. First the traditional method of maintenance, in which maintenance is performed cyclical, changes towards a quality level focused approach. According to the interviewees organizational ambitions are translated into quality levels (CROW) as it adds more flexibility since assets are not maintained based on a time schedule, but on quality indicators[14]

The municipality or executing organization is than able to determine which maintenance measures are required, or is the most effective. Moreover, the Council could implement budget cuts in maintenance leading to lower quality levels of the public space. In a simple way the maintainer could show how the space will be affected along a scale of quality levels, and link how the decisions by the Council will impact the public space (Interviewee 8-71).

Secondly, more public organizations are changing from a traditional maintenance municipality (beheergemeente) to a controlling organization (regiegemeente). This is in line with the perspective that governmental organizations need to focus on their core tasks (Graaf & Verdonk, 2003, pp. 1-2). A controlling organization refers to an agreement whereas municipalities outsource mostly service provider related tasks to market parties. The municipality reinforces the role of the client, and are responsible for supervision of the executing parties. This way of control is vertical in the sense that it differs in guidance, however the municipality is still the organization responsible for the decision making. In addition municipalities interact differently with social issues. They seek more interaction with other organizations, both public as private, to solve issues and improve cooperation. This way of control is more horizontal, as the municipalities and parties act from an equal foot. Nevertheless, both approached leads to less ‘operational’ tasks for the public organization, and more tasks on strategic and tactical level.

### *6.4.2 Maintenance approach*

Each municipality has their own unique maintenance processes, organization structure and some are further developed in (proactive) maintenance than others. Taking into account the available and obtained information the example of the maintenance process within the municipality of Rotterdam is mainly assessed, but will be extended with additional information retrieved from other interviews. The result is insight in the practical approach of maintenance within municipalities.

[14] Statement based on Emperical research (appendix C, section I and question 3 in Appendix B, Section III)

If we regard maintenance from a top-down perspective, maintenance starts with the strategic objectives of the city (Figure 6-2). These objectives are the result of municipal vision documents, and input from citizens represented by the Municipal Council. These objectives are set out in the Note Capital Goods (nota Kapitaalgoederen), and are structured to improve the cities safety, accessibility, and liveability.

In the cities model the objectives are then translated into corporate values (bedrjfswaarden). They are used to determine which measures are effective, determine how projects and measures are prioritized. In Appendix G a corporate value matrix is included. It shows how each measure is evaluated based on these values and are prioritized based on the potential risk it mitigates or solves. The decision making process based on the corporate values is seen as the maintenance strategy.


**Figure 6-2 Linkage Strategic objectives and corporate values Rotterdam (Concept Strategic Asset Management plan Rotterdam)**

The corporate values are then translated into a tactical conservation plan and maintenance management program. Another important aspect herein is the quality level of the public space. Based on the CROW quality levels, the organization or political body is able to determine the prerequisites of the maintenance policy.

In the maintenance plan an integral view upon the performed measures is given, and measures are combined based on its characteristics.

Maintenance is divided into three categories in the province of North-Holland: Usage-dependant maintenance (vast onderhoud), variable maintenance, and replacement projects (Interviewee 6-55). In the document "*Nota kapitaalgoederen met maatschappelijk nut*" the province of North Holland defined the categories as follows (Provincie Noord Holland, 2010, p. 47). Usage-dependant maintenance is small-scale maintenance that occurs cyclical and is used to prevent a drastic reduction of an assets quality level. In circumstances the quality of the asset reaches the intervention level, variable large-scale maintenance is required. This is carried out based on monitoring the condition of the asset (or through failures), or also follows a cyclical time period. A replacement project is a last resort option when both usage-dependant, and variable maintenance is no longer a viable option. In this case the asset will be replaced.

After an integral assessment in programming (Interviewee 8-71), the service provider will execute the infrastructural projects, based on a service level contract. In his maintenance he takes into account the required quality levels.

The maintenance flow as mentioned above is illustrated in Figure 6-3.

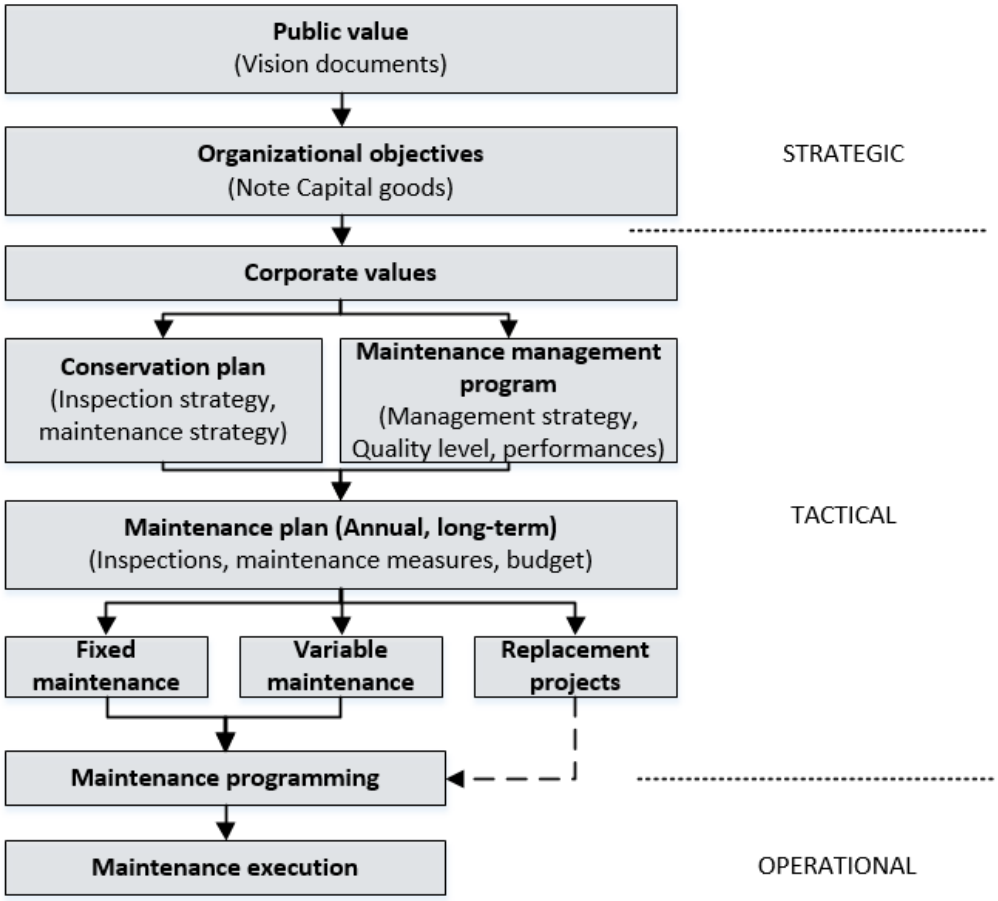



**Figure 6-3 Maintenance line-of-sight**

## 6.5 Line-of-sight within municipal maintenance

When the line-of-sight model in Figure 1-4 is compared with Figure 6-3, the largest difference is found in the absence of *functions* (Theory on the usage of functions in the Systems Engineering can be found in Appendix J, section X.). Instead municipalities tend to gravitate towards the usage of a corporate value matrix to bridge the gap between strategic objectives, and systems. Interviewee 2-9 stated that the functional consideration is done by the department City development, who are concerned with new development projects. However, they are often only involved for large maintenance projects. In such case City development will provide the City management department a list of functional requirements. It indicates that there is no functional structure present in the current maintenance process. This is acknowledged by interviewee 2-20. Functional requirements are given in the form of lists rather than in a structured form with relations to objectives, and systems.

## 6.6 Summary

In this chapter a first assessment is performed on maintenance in municipalities, based on both a theoretic research as partially empiric research.

In Asset management in which data plays a vital role, a functional structure of the whole asset network could be beneficial during maintenance. Considerations on which maintenance measures are required is than not only based on inspection results, but also on the functional usage of the asset. This component is currently lacking among all municipalities interviewed during this process (Appendix C). As Interviewee 11-94 mentioned "*It is an interesting thought. However, it doesn't have the priority at the moment*". This is the emerging rationale among the municipalities. The main focus is now to improve the maintenance process on the short-term, showing quick results, and thereby they initially focus on the vital components of AM (interviewee 2-18). We do see that municipalities are trying to get their current data up to date (interviewee 11-96, interviewee 12-101, interviewee 2-19, interviewee 3.B-33). One of the first steps is therefore an analysis on the existing asset network; what do we have (interviewee 3.A-25). Thereafter, the quality level guidelines from the CROW are followed, as it forces the municipality to maintain a particular asset to a defined level. A quality level approach is a practical method with direct results. However, it means that the municipality maintains based on how the assets look like, rather than how it should function within the asset network. This is a weakness wherein maintenance measures are determined based on keeping the asset on a specific level, rather than determined based on what is best and creates the most value in the asset network. Moreover, as the political body, the Council, does not monitor whether maintenance is compliant with the organizational objectives, but only checks whether the quality levels in the city is reached the quality level approach is currently seen as sufficient by the municipalities (Interviewee 2-12).

A functional approach is mainly interesting for complex systems such as civil engineering structures (Interviewee 2-20). For assets such as municipal green and small assets such as posts, a structure using functional decomposition might be too extensive. Interviewee 2-20 argued that a systems approach in Asset management is ambitious, but does not fit the current knowledge level of the municipal employees. Interviewee 7-68, also stated that it is still a long journey before Asset management is embraced organization wide, and the city reaches the highest level on the Asset management maturity model. In addition, projecting the state of AM within municipalities Interviewee 11-93 states that "*a functional mindset is interesting, however it isn't the prime objective"* within the maintenance.

# Chapter 7 **Empirical research results**

*This chapter contains the results from the unstructured empirical research. In addition the interview protocol used in the process consultation/ interviews is included. Sub-question IV, and V is answered.*

*Sub-research questions (see Chapter 9 )*

*IV. Which key factors could hinder the transition process for municipalities?*
*V. What are the fundamental causes of those factors?*

## 7.1 Chapter methodology

This section represents the first chapter in which a pure empirical research methodology is followed. Based on elements of a **case study** strategy, interviews with municipal employees are conducted. The interviews were used to identify the *current* maintenance approach, the future *ambition* of municipalities regarding their maintenance, and to ask them to evaluate their current processes based on the fundamentals within Asset management; the line of sight (§ 3.3). The reason it is assumed municipalities are engaged in a transition process towards Asset management is twofold: (1) in § 2.5 it was mentioned that is was improbable that an organization executes maintenance activities and follows maintenance processes without showing some key Asset management characteristics, and (2) in § 2.8 it was mentioned that municipalities have the ambition to improve their maintenance processes. The latter is in line with statements made by a number of municipalities, including Ede and Rotterdam, who identified that a lot of overdue maintenance has accumulated throughout the years (Gemeente Ede, 2016, p. 11; Gemeente Rotterdam, 2015, p. 41). Based on these criteria, the interviewees were implicitly asked how they could improve their current maintenance processes. Key notion that can be made, is that the concept of the line of sight model, information, traceability and explicit maintenance, is agreed upon; all characteristics falling under AM. Therefore, the final conclusion within this research is formed around a transition strategy towards Asset management.

Another noteworthy point is that data on maintenance within the municipality is gained from the perspective of the interviewee. It is therefore not appropriate to merely project their interpretation on the whole maintenance of the municipality. As a result, the analysis is performed using a coding structure that refers to the interviewee, and not directly to the municipality (see § 7.4). However, the interviewees are considered to have key roles within the municipal maintenance process, and therefore are assumed to have sufficient knowledge on the internal maintenance practice. In the end, a conclusion is drawn for the municipalities in general. This mitigates the fact that no detailed conclusions can be drawn for each separate city. Another mitigation method to validate the interviews is to cross reference a select few with the answers given by the interviewees on a strategic level in Chapter 8 . This cross check is performed in § 11.3. The semi-structured interviews from Chapter 8 are carried out supplementary to the unstructured interviews in this chapter to gain an understanding on how different employees on diverse hierarchical levels view their processes.

## 7.2 Interview protocol

Referring to Figure 2-1, the research model, the interview protocol is composed based on the theoretical framework established in Chapter 3 , Chapter 4 , Chapter 5 , and Chapter 6 . The interview protocol is used as an aid to support the unstructured interviews with the municipalities.

In order to answer the research question "*how to contribute towards an effective Asset Management transition process for municipalities*" the interview emphasizes two themes; (1) line-of-sight within maintenance, to determine the municipalities understanding of AM, and (2) its implementation, to gain knowledge on how to smoothen the transition process towards AM.

The core objective of the research was determining the key issues prevalent in the municipalities on the subject of asset management. It was not the purpose of the research to judge the asset management implementation level, nor to provide a benchmark. It is to come to an overall understanding and briefly outline where the municipalities in the Netherlands stands on Asset management implementation.

As it concerns an unstructured interview, questions do not always strictly follow the protocol. Instead they need to be interpreted as a checklist for a body of related questions. Advantages gained by such approach is that each interview will result in new information, insights, and new perspectives to think about. These were the main reasons to conduct the interviews unstructured, as input throughout the process were used to improve the interview protocol for the next interviews, and to provide some additional direction to the research. Disadvantages are that it hinders the empirical analysis, as questions are answered in diverse ways concerning different sub-subjects.

For the Dutch version of the interview protocol, see Appendix B, section III.

| Line-of-Sight | |
|---|---|
| 1 | How is the maintenance organization within the municipality organized? |
| 2 | How is maintenance executed, referring to the objectives, performances, and resources? |
| 3 | Which organizational objectives are defined with regards to the maintenance process, and how are they fulfilled/ substantiated? |
| 4 | In what way are you able to 'objectively' assess, and specify the impact of a maintenance activity on the operation of the total asset network? |
| 5 | Is the functionality of an asset taken into consideration in determining maintenance measures? |
| Asset management implementation | |
| 6 | If Asset management is implemented in the municipality, or when the there is an ongoing AM transition process, what was the turning point for this decision?<br>Or<br>What are the next steps to improve the maintenance process within the municipality, AM? |
| 7 | Which problems or bottlenecks are predicted when Asset management is further implemented throughout the organization? |
| 8 | Referring to the transition process undergone by the municipality, or the way maintenance is currently represented, what are the strong points the municipality has adopted? |

**Table 7-1 Interview protocol (unstructured) municipalities - English**

## 7.3 Interview sample

As stated in Stage B in §2.7, the interviewees are selected based on a set of criteria. However, the main obligation was that the interviewee had a professional understanding of maintenance, and had a profession or role relevant within the strategic chain of maintenance.

In this chapter, 13 different interviews were conducted, representing 11 different municipalities and 1 province. Among the 11 cities, 4 are large sized, having more than 300.000 inhabitants, 5 are medium sized, having a population of 100.000-300.000, and 2 are small sized, having less than 100.000 residents. In addition 1 interview is completed with an Asset management consultant employed in the province of North-Holland. The researcher acknowledges the weakness within this research in that only a broad understanding of a municipal maintenance process is identified throughout the eyes of the interviewee. The latter is crucial as how an employee observes the maintenance process does not necessarily correlate with reality.

However the argument made is that due to having different interpretations of maintenance among different municipalities, and interviewees an assessment can be made for the Dutch municipalities in general. Large variety is also found in the roles of the participants in the municipal organization. Drawing upon the Asset management hierarchical roles, the majority of the interviewees have roles on a tactical level (6 out of 13), followed by roles on an operational level (5 out of 13), and last on a strategic/tactical level (2 out of 13) (Table 7-2). Based on this composition, a broad understanding of strategic to operational maintenance can be formed. However, you should take into account that most employees carry out responsibilities that border multiple hierarchical levels. There is not always a strict hierarchical separation in practice. Therefore the allocation of the roles (strategic, tactical, and operational) should be construed broadly.

In Chapter 8 a number of additional structured interviews are conducted on a strategic level within municipalities already interviewed in Chapter 7 The objective of these additional interviews is to support the conclusions drawn from this chapter.

| **Position Interviewees** (Hierarchical level) | **Size Municipality** | | | | | |
|---|---|---|---|---|---|---|
| | ***Big** (G)* | | ***Medium** (M)* | | ***Small** (K)* | |
| | *Nr* | *%* | *Nr* | *%* | *Nr* | *%* |
| **Strategic level** | | | 2 | 40% | | |
| **Tactical level** | 3 | 60% | 2 | 40% | | |
| **Operational level** | 2 | 40% | 1 | 20% | 2 | 100% |
| | | | | | | |
| **Total** | **5** | | **5** | | **2** | |

**Table 7-2 Municipality size and Position Interviewees (interview with the province is omitted)**

## 7.4 Method of analysis

The interviews are transcribed in Dutch in Appendix C, section I. The interviews are not restructured, and therefore do not always follow the research protocol. Nevertheless, the questions stated in Table 7-1 were answered.

There are several techniques in analyzing qualitative interviews. However, the method used in this analysis follows a logical approach. Data is first transcribed and reduced when needed (Appendix C, section I), thereafter a simple reference system is created by numbering each answer of the interviewees. It consists of a composition of the interviewees number and the numbering; e.g. *Interviewee 1-14*, referring to Interviewee 1 paragraph 14. A quote-research is then followed for which the answers for the questions (§7.2), are given as quotes.

The core objectives of the analysis in this thesis is to gain an overall understanding of maintenance among the municipalities in the Netherlands, and moreover to review how Asset management could fit in the current structures. Folkestad (2008, p. 10) paraphrased that a cross-case analysis could be of value, as the collected interviews are rather standardized with a set of specific questions.

Question 1 to 5 from §7.2 is elaborated upon with an explanation on its inclusion. Thereafter a matrix table is made that compares how each municipality scores based on how it would fit the Asset management mindset (Table 7-3). Questions 6 to 8 are not included in a matrix template, as the content doesn't fit the matrix framework. The projected results are anticipated on whether municipalities in the Netherlands currently understand the strategic importance of objectives during maintenance (line-of-sight), and the best practical approach during transition towards Asset management.

| Interviewee | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | | *G* | *G* | *G* | *M* | *M* | | *G* | *M* | *K* | *K* | *M* | *M* | |
| *[Assessment Criteria/ Theory]* | *Rate* | | | | | | | | | | | | | |
| *[Characteristics 5]* | ++ | | | | | | | | | | | | | 0 |
| *[Characteristics 4]* | + | | | | | | | | | | | | | 0 |
| *[Characteristics 3]* | O | | | | | | | | | | | | | 0 |
| *[Characteristics 2]* | - | | | | | | | | | | | | | 0 |
| *[Characteristics 1]* | - - | | | | | | | | | | | | | 0 |

**Table 7-3 Interview question matrix table**

The matrix table should be read as follows. In the "Assessment criteria/ theory" the subject of analysis is stated. It refers to the asked interview question (Table 7-1). There are 5 different scales of rating "- -, -, O, +, ++", whereas the poorest rating "- -", is given to municipalities that conform to the "Characteristics 1", and the highest rating "++" is given to those conforming to "Characteristics 5".

Note that the interviewees "3.A" and "3.B" are merged into "3", as they are applicable to the same municipality.

### *7.4.1 Interview results: the Line-of-sight*

The interviewees are asked to outline their maintenance organization, and moreover the process flows from strategic to operational departments.

**1. How is the maintenance organization within the municipality organized?**

The assessment criteria is on whether the organizations sees their assets as an important enablers of creating value, and have structured their organization as such to support it (Table 7-4).

Literature study in §1.2 has shown that there are largely three hierarchical levels and roles with clear responsibilities; Asset owner on the strategic level, Asset manager on the tactical level, and Service provider on the operational level. Appendix J, section VII shows that the natural hierarchy within municipalities already support this organizational division.

The GFMAM (2014, p. 39), a collaborative group consisting of institutes concerned with the advancement of Asset Management, developed a guide "*The Asset Management Landscape*" with the objective to align knowledge and practices of Asset management. This guide is based on the NEN-ISO 55000, and includes supportive information on the ISO standard. In this context, *Organizational Structure* is defined as "*the structure of an organization in terms of its ability to deliver the organizational and AM objectives*" GFMAM (2014, p. 39). What structure fits the best depends on a number of factors such as ownership structure, objectives and strategies, and maturity of the organization. However, what is interesting to note is that GFMAM stated that "*the organizational design should be aligned with the organization's desired leadership style and culture…as misalignment could lead to undesired outcomes*" GFMAM (2014, p. 39). To address the maintenance organization of the municipality, the municipality should not only be assessed on the organization structure, but also on what kind of leadership and culture the organization has adopted.

The NEN-ISO 55001 furthermore pointed out the importance of the responsibilities within the organization. Important is that the top management should have assigned tasks within the organization to ((International Standards Organisation, 2014b, p. 3):

- Establishing and updating the Strategic Asset Management Plan (SAMP), including AM objectives
- Ensuring that the Asset Management System (AMS) supports delivery of the SAMP
- Ensuring the suitability, adequacy and effectiveness of the AMS
- Establishing and updating the AM plans
- Reporting on the performance of the AMS to top management

Based on the alignment of the leadership style mentioned by GFMAM, and the 5 tasks stated in the NEN-ISO55001, the municipalities are assessed using a 5 stage ranking base on the characteristics of the municipality.

*Characteristic 1: The leadership style of the organization is not aligned with the AM philosophy. Moreover, there is no SAMP, no adequate AMS, and the performance of the AMS is not reported to the top management.*

Municipalities falling in this category are Interviewee 1, and 4. Interviewee 1-4 states that from a practical perspective (and as seen by the management) it is not needed to understand how an asset influences the accessibility of the city, even though this is usually one of the main organizational objectives within the municipality (Figure 6-2). It shows that the leadership is not yet advanced in the AM philosophy. Moreover, interviewee 1-6B mentioned that he does not "*exactly substantiate what he does*", but only focuses on keeping the asset available. Coordination with other departments is done ad hoc (interviewee 1-6C). It shows that his department is quite isolated, and not fully integrated with other departments.

Interviewee 4-41C states that there is an Asset manager that only manages on budget, while the maintainer manages on the asset. As a result there is a certain role conflict between the two as their goal is not aligned. Moreover, the current AM implementation, including any improvements in maintenance, is put on halt as the new AMS system is yet to be rolled out (interviewee 4-46A). However, this is already ongoing for 6 years, indicating years of maintenance stagnation.

*Characteristics 2: The leadership acknowledges the benefits, however no concrete plans are undertaken to align the whole organization. Moreover there is no SAMP, but there is an attempt made to improve the asset network with a quality level approach. An AMS is integrated subpar (required information when needed), and not always the correct information can be retrieved.*

Municipalities falling in this category is Interviewee 9. Interviewee 9-78A recognizes the importance of a quality level approach maintenance. However, they are currently in the development phase. Due to its small size he has the advantage to make improvements in the decision making process, but acknowledged that most decisions are currently made ad hoc (interviewee 9-82A). Moreover, there is a wish to improve the integration of the departments, but it is not yet clear how this is done practically (interviewee 9-78D).

*Characteristics 3: The leadership is fully supportive for the AM implementation. Concrete plans are being executed to further this agenda. There is no SAMP, but attempts are made to prioritize AM measures for the asset network. An AMS is integrated subpar (required information when needed), but measures are taken to remove erroneous information.*

Municipalities falling in this category are Interviewee 3, 10, and 11. Interviewee 3.A-25A mentioned that they are currently assessing on how they could involve market parties in the maintenance process. In addition progress is also made in the asset system and documenting the maintenance processes (interviewee 3.B-33, interviewee 3.A.-31). It shows that the municipality is heading into the right direction. However, interviewee 3.B-33 stated that the current AMS system contains erroneous data due to corrupt imported information (interviewee 3.B-33).

Interviewee 10-84C mentioned the short lines between departments, due to the size of the municipality. He also stated that he performs multiple roles within the organization (Interviewee 10-83). Whether this improves the integration of departments, or is a weakness due to a limited point of view is yet to be determined. Nevertheless there is an AM rationale noticeable within the organization as ambitions of the municipality are translated into measures (interviewee 10-85B). Moreover, he is very aware of the trends in maintenance, and is actively adapting new approaches to make improvements (Interviewee 10-88).

Interviewee 11-95B stated that they're now actively assessing the potential of Asset management within their organization. The leadership acknowledges the importance of the method, but it is yet to be supported throughout the whole organization (Interviewee 11-95D). Moreover, their current maintenance is quality level focused, but the way their budget is distributed indicates a traditional philosophy (interviewee 11-91B).

*Characteristics 4: The leadership is able to convey the need for AM, and the Asset owner is supportive. Start state of the organization is identified, as well as the end state. There is an attempt to create a SAMP. There is an AMS with critical information, however not yet all information can be retrieved and is reported.*

Municipalities falling in this category are Interviewee 2, 5, 7, 8, and 12. The Asset owner delivers the objectives and prioritizes them, the Asset manager then translates them into maintenance measures based on a quality level approach. The leadership within the municipalities are also aware of its role as a controlling organization, and outsources the maintenance to the service provider, with area-based contracts (outcome focused) (interviewee 2-11C, interviewee 5-48A, interviewee 7-62D, interviewee 8-71C). Interviewee-12-99A still applies output focused contract forms. In addition many have reorganized to align their organizational structure with the new maintenance working methods (Interviewee 12-98A, interviewee 5-52B, interviewee 7-69, interviewee 8-71). It is intriguing that the mentioned municipalities mentioned above follow near identical processes, but not all regard it as AM. Interviewee 2-22A, interviewee 7-69, interviewee 12-101A define their approach as Asset management, and attempt to develop their maintenance structures in line with the AM guidelines. However, interviewee 5-48A, interviewee 8-74A do not specifically regard it as an AM process, but rather group their activities as an integrative approach within maintenance. In the end they end up with the same approaches with nuanced differences in the kind of contract forms, and responsibilities on the operational level (interviewee 11-57A).

*Characteristics 5: The leadership extends from the strategic towards the operational levels. There is a SAMP which includes how assets need to perform to comply with the objectives. An AMS is fully integrated and measures are taken to continually improve the system.*

Municipalities falling in this category is Interviewee 6. Interviewee 6-57C stated that the province has created a whole AMS, written out all processes, and has supported it with a SAMP. Interviewee 6-59A mentioned the importance of the top level management. They acknowledged the need of change within maintenance, and had a strong vision to support it (Interviewee 6-59A). He also implied they have a working line-of-sight worked out in processes and documents. Moreover, they are already working following this approach and are constantly evaluating to determine improvements (Interviewee 6-57C).

| Interviewee | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | | *G* | *G* | *G* | *M* | *M* | | *G* | *M* | *K* | *K* | *M* | *M* | |
| *[Assessment Criteria/ Theory]* | *Rate* | | | | | | | | | | | | | |
| *[Characteristics 5]* | **++** | | | | | | x | | | | | | | 1 |
| *[Characteristics 4]* | **+** | | x | | | x | | x | x | | | | x | 5 |
| *[Characteristics 3]* | **O** | | | x | | | | | | | x | x | | 3 |
| *[Characteristics 2]* | **-** | | | | | | | | | x | | | | 1 |
| *[Characteristics 1]* | **- -** | x | | | x | | | | | | | | | 2 |

**Table 7-4 Matrix Question 1**

### 2. How is maintenance executed, referring to the objectives, performances, and resources?

The assessment criteria is on how the maintenance measures are determined looking back at objectives, performances, inspections, resources (Table 7-5).

In the paper "*The Relationship between Asset management and Performance management*", developed as part of the National Cooperative Highway Research Program, Cambridge Systematics (2012) argued the strong link between the concept Performance management, and Asset management. Moreover, they referred AM as applying the principles of Performance management to the management of the physical assets. The performance of the system regards concepts such as safety, efficiency, environment, capacity, operations, users, condition, and information. Cambridge Systematics (2012, p. 2) stated that Performance management at the highest abstraction level is about "*linking agency goals and objectives with resources and results*". It corresponds with the theory examined in Chapter 1 . With this statement in mind, maintenance measures executed by municipalities should follow a likewise pattern, in that there should be a substantiated decision making process in place to determine measures not only based on inspection results, but also on the agency goals and objectives. The following aspects were perceived critical by Cambridge Systematics (2012, p. 3):

- **Goals/ objectives:** resource allocation and decisions based on desired long-term conditions of assets.
- **Performance measures:** policy objectives are translated into performance measures reflecting the desired condition or health of physical assets
- **Forecasting Performance and Target setting:** Decisions are based on an analysis of how different allocations will impact achievement of goals and objectives
- **Resource allocation decisions based on quality information:** Decisions support tools are used to track system conditions and forecast performance
- **Measuring, evaluating and reporting performance results:** Performance impact of programs and projects are tracked over time and evaluated

Based on these 5 points the following assessment characteristics are created.

*Characteristics 1: There are no formalities in place, and maintenance is mostly reactionary. Decisions are not made based on the agency objectives. Moreover, each discipline has their own data system, leading to scattered information.*

Municipalities falling in this category is Interviewee 4.

*Characteristics 2: Maintenance is mostly reactionary, with preventive measures ad hoc. Data on compliance with the Performance measures is not readily available. Decisions are not made based on the agency objectives.*

Municipalities falling in this category is Interviewee 1, 4, and 9. The municipality still maintains a large internal operation service (Interviewee 9-77). However, with the formulation of a new maintenance policy, increased cooperation with market parties is looked upon (interviewee 9-82B). Currently, interviewee 9-82A mentioned that many improvements should be made in the processes, responsibilities, and communication, as there is a trend noticeable that the maintenance measures will be determined based on certain performance indicators, but currently it is still very reactionary (interviewee 9-78D).

Interviewee 1-2B aims to keep the asset above the threshold by keeping the performance of the asset high at all times. Maintenance activities are taken preventively following a maintenance cycle, instead of based on monitoring the condition of the asset (interviewee V.1[15]).

Interviewee 4 starts with performing inspections, and bases the required maintenance measures only on these results (Interviewee 4-40). There are organizational objectives, but there are no formalities in place to translate them into actual measures, or to report them back to the top management (interviewee 4-41A). Moreover, interviewee 4-41B stated that the current data system is aged, and is only used as a simple database. However, even though the maintenance plan is aged, there are preventive maintenance activities conducted (Interviewee V.4[16]).

*Characteristics 3: Maintenance is mostly preventive, with reactionary measures ad hoc. Data is documented, and there are Performance measures identified. Decisions are based on an analysis of the performance results.*

Municipalities falling in this category are Interviewee 3, 11, and 12. Interviewee 3.A-25B, and interviewee 1-2A follow the guidelines set out in the NEN 2767. The norm contains a decomposition of assets and the required performance levels. Based on inspection results, the municipality aims to keep the asset above the threshold (Interviewee 1-2B, interviewee 3.A-25A).

Interviewee 11-91A maintains the public space based on the quality levels, and on the required performances of the assets. However, the way the quality levels are determined and reported back to the top-level management, is through employing a simple survey among the citizens (interviewee 11-91A). Outside the significance of the technical inspections, maintenance measures are not prioritized based on ambition levels or objectives (interviewee 11-96A).

Interviewee 12-99A cited that they start out from the quality levels, and the performances of assets. The decisions are based on the performance results, and prioritized based on the technical urgency of the asset (Interviewee 12-99C).

*Characteristics 4: Maintenance is determined based on performance objectives. Moreover, the measures are strategically prioritized. Data is documented and monitored.*

Municipalities falling in this category are Interviewee 2, 5, 6, 7, 8, and 10. Interviewee 5-48B stated that they have a strategic department analyzing the asset data to determine the maintenance needs. Along with the quality levels, on the tactical level the practitioners uses the prerequisites to cluster projects. The market parties are responsible of the execution, and the manner they ensure their quality (Interviewee 5-48D). It involves data documentation, and continuous monitoring.

According to interviewee 6-56B, the maintenance is performed systematically in the municipality. The maintenance follows the same principles as interviewee 5. However instead, the service

[15] Results from validation round, see Appendix I, section III, interviewee V.1
[16] Results from validation round, see Appendix I, section III, interviewee V.4

provider not only executes the maintenance measures, but determines them themselves based on the performance thresholds included in the contract (interview 6-57A).

Interviewee 7-62B follows the ambition directives set out by the municipality. Based on those criteria, and performance levels, the maintenance measures are prioritized and determined. RAMSSHEEP performances are acknowledged, but is not particularly steered on (interviewee 7-64). Eventually the service provider executes the required measures.

Interviewee 8-70 and interviewee 2-11C maintains based on the ambition directives, and the quality levels set out by the city. Which maintenance measures are required is based on the performance indicators, and technical inspections retrieved from the data system (interviewee 8-71A, interviewee 2-10A). Whether the required ambition and performance levels were reached is reported back to the top level management.

Interviewee 10-84B uses a risk-based approach in determining whether maintenance is required. Data used for the analyses follows from a model which includes inspection results, which are framed around the ambition guidelines of the city (interviewee 10-85B).

*Characteristics 5: Maintenance is aligned with the agent objectives. Decisions are made base on how it effects the objectives. Data is documented, evaluated, and forecasted.*

None of the municipalities are at the stage wherein the maintenance measures are explicitly traceable to the agency objectives. The gap between organizational objectives and ambition level is still blurred.

| **Interviewee** | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size** | | *G* | *G* | *G* | *M* | *M* | | *G* | *M* | *K* | *K* | *M* | *M* | |
| *[Assessment Criteria/ Theory]* | *Rate* | | | | | | | | | | | | | |
| *[Characteristics 5]* | **++** | | | | | | | | | | | | | 0 |
| *[Characteristics 4]* | **+** | | x | | | x | x | x | x | | x | | | 6 |
| *[Characteristics 3]* | **O** | | | x | | | | | | | | x | | 3 |
| *[Characteristics 2]* | **-** | x | | | | | | | | x | | | x | 3 |
| *[Characteristics 1]* | **- -** | | | | x | | | | | | | | | 1 |

**Table 7-5 Matrix Question 2**

### 3. Which organizational objectives are defined with regards to the maintenance process, and how are they fulfilled/ substantiated?

The assessment criteria is what the municipals strategic objectives are, and what their place is within the maintenance process (Table 7-6).

GFMAM (2014, p. 9) states that at the highest level a conceptual model of Asset management should include a number of key aspects. One of which the "*reinforced alignment to organizational goals and objectives"*. This is also mentioned in the NEN-ISO 55001 whereas there should be asset management objectives at each relevant level of the organization, which on their own are "*consistent and aligned with the organizational objectives*" (International Standards Organisation, 2014b, p. 4). So there needs to be two different sets of objectives; organizational objectives, and Asset management objectives. From a practical perspective just identifying and complying with the AM objectives (i.e. quality levels) is workable. However, there is also a need to include strategic objectives in the maintenance process, as frequently mentioned in the ISO norm, and GFMAM.

The alignment with the agency objectives is regarded as problematic. Interviewee 8-63B stated that in the general budget promises are made based on the strategic objectives, however in the

reports there is not always an adequate linkage between performance, activities and objectives. This is a step many municipalities struggle with. Interviewee 2-14A, mentioned that this step is a lot harder to substantiate.

Therefore, in this section it is assessed how an organization deals with their strategic objectives. The following characteristics are created:

*Characteristics 1: The organization has not formulated strategic objectives or they are not known.*

None of the municipalities fall in this category. They all have defined strategic objectives.

*Characteristics 2: The organization has formulated strategic objectives. However these are not widely acknowledged or meaningful used.*

Municipalities falling in this category is Interviewee 1, and 4. Interviewee 1-8 argued that the main objective of maintenance is to merely keep the asset "*operational and comply with the statutes*". There are no strategic objectives to which he has to comply, even though the municipality has formulated them. Further assessment of the linkage within the decision making process is from a practical perspective not yet needed (Interviewee 1-4).

Interviewee 4-41A stated the existence of strategic objectives; Clean, Safe, and Intact. However, the degree to which these objectives are fulfilled is only based on a complaint registration by the citizens (Interviewee 4-41A). Which maintenance measures has contributed towards the creation of value is not evaluable.

*Characteristics 3: The organization has formulated strategic objectives and Asset management objectives, but the latter were formulated without considerations to the strategic objectives.*

Municipalities falling in this category are Interviewee 9, and 11. Interviewee 9-80 mentioned a few policy themes such as safety, and sustainability. However, the Council only focuses on the quality levels. Moreover, it is remarkable that all quality levels are set on "*basic*", indicating that these ambition levels were set without considerations to the strategic objectives (interviewee 9-80).

Interviewee 11-92A stated that besides the strategic objectives such as Clean, Safe, and Intact, no hard objectives are formulated by the Council. Identical to interviewee 9, the Council only assesses based on the quality levels. However, there are no indications that these were based on the objectives.

*Characteristics 4: The organization has formulated strategic objectives and Asset management objectives. There is still a lack of alignment with the organizational goals, but the AM objectives are referred to throughout the whole organization.*

Municipalities falling in this category are Interviewee 2, 3, 5, 6, 7, 8, 10, and 12. Objectives such as Clean, Safe, and Intact are often cited as the strategic objectives, and used as leading principles within maintenance (interviewee 2-11A, interviewee 3-23, interviewee 7-62B, interviewee 12-97A). However, these municipalities have also defined corporate values as an intermediate step between the strategic objectives, and maintenance measures (interviewee 2-15B, interviewee 3-30B, interviewee 6-59B). By using a corporate value matrix they are attempting to bridge the gap between strategy and the operational level (Appendix G). A corporate value matrix is a tool to prioritize maintenance measures based on the identified corporate values and risks.

Interviewee 5 and 8 has not cited the usage of a corporate value matrix. However, this might be due to their contract form with the service provider. They adopted area-focused performance

contracts, which indicates that they have shifted more of the responsibilities to the service provider (interviewee 5-48A, interviewee 8-71C). Moreover, these service providers receive the organizational objectives of the municipality to adopt them in their own working processes, which on their own are evaluated by the municipality (interviewee 5-49A, interviewee 8-71B).

Interviewee 10-85A tackles this problem by translating the strategic ambitions of the city into ambitions applicable to his department (i.e. wastewater). This approach is also adopted by the other disciplines in the municipality.

Interviewee 12-97A argued that there are multiple ways to reach compliance with the strategic objectives. Their approach is by formulating the maintenance framework based on the municipality's policy, and vision. Thereafter, these are tuned based on input from the citizens, where after the quality levels are determined, and the program for maintenance is created.

*Characteristic 5: The organization has formulated strategic objectives and Asset management objectives. There are all aligned and acknowledged as the methodology to substantiate the creation of value.*

None of the municipalities are at the stage wherein the organizational objectives are explicitly used in the maintenance process as starting point.

| **Interviewee** | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size** | | *G* | *G* | *G* | *M* | *M* | | *G* | *M* | *K* | *K* | *M* | *M* | |
| *[Assessment Criteria/ Theory]* | *Rate* | | | | | | | | | | | | | |
| *[Characteristics 5]* | **++** | | | | | | | | | | | | | 0 |
| *[Characteristics 4]* | **+** | | x | x | | x | x | x | x | | x | | x | 8 |
| *[Characteristics 3]* | **O** | | | | | | | | | x | | x | | 2 |
| *[Characteristics 2]* | **-** | x | | | x | | | | | | | | | 2 |
| *[Characteristics 1]* | **- -** | | | | | | | | | | | | | 0 |

**Table 7-6 Matrix Question 3**

### 4. In what way are you able to 'objectively' assess, and specify the impact of a maintenance activity on the operation of the total asset network?

The assessment criteria is on whether municipalities are aware on how an asset could impact the whole asset network, and how it could influence the value creation positively or negatively (Table 7-7).

The NEN-ISO 550001 states that an "*organization shall determine its information requirements to support its assets, asset management, and asset management system*" (International Standards Organisation, 2014b, p. 6). The way an organization chooses to do this is not specified. However, in a presentation created by EPA (2016), it was mentioned that the development of an asset register is a crucial component of Asset management. Without a clear structure, it is impossible to identify the links of cause and effect. EPA (2016, p. 12) referred to it as a "*hierarchical parent, child"* relation. Moreover, there needs to be a one point of access of information cross disciplines, as overlap in maintenance is inevitable.

Due to the importance of a coherent asset structure, the following characteristics are formulated:

*Characteristics 1: Asset data is completely fragmented, and is only requested for ad hoc maintenance activities.*

Municipalities falling in this category are Interviewee 4, and 9. Interviewee 4-41B mentioned he is unable to include complex data relations in the current data system. There are no considerate

integration efforts made with other disciplines, and decisions are tackled ad hoc with predominant heuristic considerations (interviewee 4-46B).

Interviewee 9 has no integrated data system in place cross disciplines. Even though he acknowledges its value, the top level management has shown no interest yet (interviewee 9-82A) Priority is given to completing inspections, and the deployment of the new maintenance plan with quality levels (interviewee 9-78A).

*Characteristics 2: There is an attempt made to structure the Asset data. However, this solely done within the disciplines. It does however link this data with financial information on the asset.*

Municipalities falling in this category are Interviewee 1, 8, 10, and 11. Interviewee 1-6A mentioned that the systems are elaborated upon in the maintenance plans, containing a decomposition obtained from the NEN standard (interviewee 1-2A). However, no further efforts are attempted to tailor it towards the whole asset network.

According to interviewee 8-72B the municipality is aware on how one asset affect another. However, there is no specific system in place to determine that. The considerations are done "*verbally, with key figures, and manually*" (interviewee 8-72B). Nevertheless, the disciplines within the municipality are actively engaged to restructure and improve the process (interviewee 8-74B).

Interviewee 10-85A asset data is structured per discipline. Attempts to integrate are done verbally, due to the short lines between the departments (interviewee 10-84C). Moreover, interviewee 10-86 mentioned that the impact of one asset on another is not always quantified, but interfaces between for example a road, and a sewerage is analyzable.

Interviewee 11-93 accepted that they are currently unable to determine the impacts within the asset network. Assets are identified and incorporated in maintenance packages, but there are no explicit integration steps taken to manage the maintenance cross disciplines. Fundamentally, the departments are still operating separately (interviewee 11-91B).

*Characteristics 3: There is an attempt made to integrate the Asset data across the disciplines. Moreover, there is a link with financial information of the asset, and maintenance measures.*

Municipalities falling in this category are Interviewee 2, 3, 5, 7, and 12. Interviewee 2-19A acknowledges the importance of having 1 model within AM, but confesses that there are still improvements to make in the data component. However, the financial needs are linked to each asset in the system (interviewee 2-16A, interviewee 7-62A).

Interviewee 3.B-33 states that they have an integrated asset system for all disciplines with the exception of one. However, not all users of the database have linked the financial data in the model. It indicates that the basic stands, but the processes are still lacking. In addition interviewee 3.A-25A, states that the current assets in the municipality are currently incorporated in the system based on a certain decomposition.

Interviewee 5-51C and interviewee 12-100A cited that there are attempts made to cluster data city wide. However, a full overview of assets cross disciplines is not yet created. Moreover, in their opinion the service provider is responsible for creating, and maintaining the asset data system. They do however, request insight in the determination of AM decisions based on asset data.

*Characteristics 4: Asset data is aimed at supporting the long term maintenance and financial requirements. It is structured to support the Asset management decision making process.*

Municipalities falling in this category is Interviewee 6. Interviewee 6-59A states that the asset system of the municipality functions correctly. In their SAMP it is noted that they are able to create long term asset planning based on age, data of maintenance execution, and quality. The municipality is at the stage that they could use the asset data for forecasting (interviewee 6-59B).

*Characteristics 5: Asset data is extensive and correct. The Asset management decision making process is supported by its linkage with the maintenance and financial considerations. Moreover, the Asset manager is able to retrieve information relevant to cause and effect.*

None of the municipalities are at the stage wherein there is an explicit linkage between assets, including cross disciplinary, to enable cause and effect determination of failures, but also at creating value.

| **Interviewee** | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Size** | | *G* | *G* | *G* | *M* | *M* | | *G* | *M* | *K* | *K* | *M* | *M* | |
| *[Assessment Criteria/ Theory]* | *Rate* | | | | | | | | | | | | | |
| *[Characteristics 5]* | **++** | | | | | | | | | | | | | 0 |
| *[Characteristics 4]* | **+** | | | | | | x | | | | | | | 1 |
| *[Characteristics 3]* | **O** | | x | x | | x | | x | | | | | x | 5 |
| *[Characteristics 2]* | **-** | x | | | | | | | x | | x | x | | 4 |
| *[Characteristics 1]* | **- -** | | | | x | | | | | x | | | | 2 |

**Table 7-7 Matrix Question 4**

**5. Is the functionality of an asset taken into consideration in determining maintenance measures?**

The assessment criteria is on whether municipalities approach functionalities of a system the same way as the technical requirements of the system (Table 7-8).

The literature study in §6.5 has shown that a functional structure between objectives, and the asset system could be useable to objectively determine maintenance measures without focusing on the assets. A functional perspective could lead to a situation where the failure of one asset system is chosen, as the existence of another takes over.

An example is a tunnel in which the lighting has an availability requirement of 95%. During monitoring it is determined that the 94, 5% of the lighting is operative. However, from a functional standpoint the safety of the tunnel is not undermined as the visibility of the road marking is sufficient in this specific area where the lighting has failed. This is a simple example that shows that a functional mindset leads to other decisions compared to an object approach.

The following characteristics are formulated:

*Characteristics 1: The organization is not aware of the importance of a functional approach in maintenance, and does not support it.*

None of the municipalities disregard a functional approach in maintenance.

*Characteristics 2: The organization is aware of the importance of a functional approach in maintenance, but sees a limited utility in it.*

Municipalities falling in this category is Interviewee 9, and 11. Interviewee 9-78E states that the maintenance processes in the municipality are not yet advanced that functionalities were considered. However, they are aware of its potential (interviewee 9-82A).

Interviewee 11-94 cited that it has potential, but currently does not has the priority.

*Characteristics 3: The organization has a fragmented approach towards asset functionality. It is something in their mind during maintenance, but there are no formal structures in place.*

Municipalities falling in this category are Interviewee 1, 2, 3, 4, 7, and 10. Interviewee 4-43 states a functional mindset is not yet implemented in the municipality. However, some functional requirements are considerate separately and ad hoc during maintenance (interviewee 4-40). There is no control on whether asset satisfies the functional requirement, but an informal assessment is done by the maintainer himself (interviewee 4-40).

Interviewee 1-5 and interviewee 3.A-30A mentioned that the municipality does look to the functionality of an asset before it is created. Moreover, the followed NEN standard includes how the asset should function (interviewee 1-2A, interviewee 3.A-30B). Nevertheless, the main determinant in maintenance decisions is still the technical component (interviewee 1-3A). There is no explicit linkage between objects and functionalities yet, as it is conducted "*intuitively*" (interviewee 3.A-25B). Interviewee 3-35A states that their main task is to keep everything functional; it should work.

Interviewee 2-9A often receive functional requirements from other departments, when maintenance measures are determined. However, with smaller scale maintenance activities they do not approach it functionally (Interviewee 2-9B). Moreover, the municipality recognizes the utility of decomposing the assets functionally, but states that this is not always useful depending on the complexity and size of je object (interviewee 9-20A). The functional maintainer does however manages and report based on compliance with the functional objectives (interviewee 2-11D).

Interviewee 7-64 mentioned that functionalities are assessed, but there is no active control on its compliance. Further developments are needed in this area.

Interviewee 10-87 mentioned that these considerations are only recently incorporated. However, external consultants and researchers are hired to advise the organization for maintenance activities.

*Characteristics 4: The organization manages and controls on functions, and assets are analyzed technically and functionally.*

Municipalities falling in this category are Interviewee 5, 6, 8. And 12.

Interviewee 5-50A, 6-57A, 8-71C, and 12-99A states that the contracts are not prescribed technically, but boundaries are given in the form of performances, and functionalities. In this case the contractor determines the need of maintenance measures based on the performance levels, and the added value of an asset towards the functionality of the network.

*Characteristics 5: The organization has fully decomposed his assets functionally, and has included it in his asset data system with the relevant linkage to other element.*

None of the municipalities meet the characteristics presented in this section.

| Interviewee | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | | G | G | G | M | M | | G | M | K | K | M | M | |
| [Assessment Criteria/ Theory] | Rate | | | | | | | | | | | | | |
| [Characteristics 5] | ++ | | | | | | | | | | | | | 0 |
| [Characteristics 4] | + | | | | | x | x | | x | | | | x | 4 |
| [Characteristics 3] | O | x | x | x | x | | | x | | | x | | | 6 |
| [Characteristics 2] | - | | | | | | | | | x | | x | | 2 |
| [Characteristics 1] | - - | | | | | | | | | | | | | 0 |

**Table 7-8 Matrix Question 5**

### *7.4.2 Interview results: Asset management implementation*

The results from the questions included in this sub chapter should give insight in how the transition process towards Asset management for municipalities could be improved. Interviewees are asked to describe what the key point were during change, and or what the expected bottlenecks could be.

**6. If Asset management is implemented in the municipality, or when the there is an ongoing AM transition process, what was the turning point for this decision? Or what are the next steps to improve the maintenance process within the municipality, AM?**

Interviewee 12-101A gave a thoughtful answer stating that the term Asset management has many forms. In short he mentioned that a vital element of it is having a 'good' data system, with up to date, correct information. This statement is shared by many others, including Interviewee 2-19D and interviewee 3.A-32B.

The turning point for Asset management implementation follows a similar pattern among those who have. Maintenance improvements was required as the state of their assets were declining, there was overdue maintenance, a shift was endeavored towards risk based maintenance, the needed to substantiate their needs towards the political body, there was less capacity available, funds were reduced, and the organization needed to be more transparent (interviewee 2-22A, interviewee 5-54, interviewee 6-59A, interviewee 7-69).

To improve the maintenance processes, not only the primary processes need to be tackled, but also "*the supporting roles, and the facilities*" (interviewee 7-68B). Interviewee 12-97A started by restructuring the organization along three pillars; policy, program, and execution of maintenance. These can be seen as the strategic, tactical, and operational levels. Giving a timeframe of 10-15 years to structure an organization in line with the primary process shows that it costs a lot of time, resources, and capacity (interviewee 7-68C). However, depending on the size of the municipality, the required resources could vary.

In order to increase the effectiveness of maintenance, municipalities need to determine how strategic objectives are used in the maintenance considerations. Interview question 3 shows how they're currently managing the translation; they're struggling. As it concerns a complex process, municipalities share information on how maintenance could be improved both theoretically, and practically. Interviewee 11-96B predominantly looks at Interviewee 2 as an example for setting up a corporate value matrix. It indicates that municipalities are not really concerned into implementing Asset management, but are rather looking for practical options to improve their current maintenance activities. Hence, we see many are adopting a corporate

value matrix, quality levels (CROW), and are restructuring to outsource maintenance to market parties through area-specific contract forms (Interviewee 9-77, interviewee 12-98B). Even though municipalities are not fond on implementing Asset management, they are taking example of municipalities far developed in AM. An effect is that the municipalities are all gravitating towards a state that resembles the methodology, but lack components deemed not needed within the particular municipality. As a result they'll reach an end state that is far more efficient than how they started, but they will still have difficulties improving the effectiveness of their maintenance.

**7. Which problems or bottlenecks are predicted when Asset management is further implemented throughout the organization?**

When asked about the bottlenecks of further Asset management implementation, two different answers are given; technical, and emotional. The first refers to deficiencies in the current maintenance process that need to be solved in the future. For example interviewee 2-19A mentioned that when you want to apply good Asset management, 1 general model is required. It means that all disciplines need to work integrally together, using 1 data system, and using 1 decision model for maintenance measures. It requires the possibility to compare objects. This might refer to the need of establishing ways to display relations between assets, leading to possibilities showing the impact of 1 asset on another. Furthermore, interviewee 5-53C mentioned that not only the maintenance departments need to work more integrally, but also the maintenance department, and the new developments departments. Currently they're still divided into separate project teams.

Another perquisite mentioned by interviewee 2-19C is the need of Asset management at the service provider organization. There needs to be a "*continuous line-of-sight*" throughout the whole organization, regardless whether it concerns an external market party. This also means that organizations need to think about the role divisions throughout the organization. Interviewee 7-68D argued that strategic organization components (in city districts) within mainly executing branches of the organization counteracts the efficient workings of the organization. It refers to that those city district currently have similar strategic responsibilities as the central municipal organization. It results in divergent objectives between city districts, and thereby fragments the line-of-sight.

The emotional bottlenecks are given by interviewee 5-53B, who stated that the new role the municipality has adopted as a governing organization, is very complex. One who is used to working in a particular manner (heuristics), looks different at change. There is an existing culture that will lead to resistance (interviewee 8-75B). It requires "*guts*" to shift a lot of the responsibilities to the service provider, and ask him the right questions.

Interviewee 6-60A mentioned that most problems are apparent in the component leadership. He mentioned that within municipalities, the political body consisting of the Executive board, and the Council are not inclined to see themselves as the Asset owner. This might be one of the causes of the lack of linkage between the strategic level and the tactical level within municipalities.

Moreover, a problem could lie in the fact that there is insufficient knowledge within municipalities regarding AM (interviewee 6-60B). It is "*impossible for municipalities to attract high educated technical personnel*" (interviewee 5-52B). Especially, in small cities this could lead to huge

knowledge gaps. As a result, municipalities, not belonging to the biggest in the country, await developments made by the biggest cities. This leads to the point whereas municipalities pick out selected AM processes, and tools.

A change on an organizational level, impacts the employees. People will lose their jobs, there will be job insecurity.

Another problem, typical for municipalities, is that they are responsible for many things ranging from social safety to youth care. It is the question how much citizen's notices the difference between Asset management compared to the current approach. If there are limited funds, and the Council has to choose between maintenance, and a social affair, that decision is complex to make (interviewee 6-60C).

**8. Referring to the transition process undergone by the municipality, or the way maintenance is currently represented, what are the strong points the municipality has adopted?**

The reason of asking this question is to gain insight in the transition process of a municipality, and determine what the key factors are within such process.

Interviewee 3.B-93 stated that an important factor is that transparency within decisions is important. The political body is responsible for allocating the available budget. By making informed decisions, they are able to communicate what they want, and why. "*The governing body, and the civil servants need to speak the same language*" (interviewee 8-76B). It means that they understand the objectives, each other's interests, and understands them. It also refers to making clear what the drivers of change are.

Another is to believe in your own process, and change. Interviewee 5-53B mentioned that at the start of the change process few thought that the maintenance could be executed within the given budget, with the new maintenance process. However, now no one argues that fact anymore.

Interviewee 10-89 stated that what works for one municipality, doesn't always work for another. For such he mentioned a used model in the sewer maintenance plan that merely worked as the municipality possessed characteristic only applicable to their underground. In conclusion, one should acknowledge the internal and external context of the organization.

Finally interviewee 12-102A mentioned a bottom-up approach during the transition process. With the employees on the work floor ideas were shared on the next steps and organizational structures. Eventually a plan was created that had support of more than half of the organization.

In addition interviewee 12-102C mentioned that they adopted a learning by doing attitude. A framework was created on a high abstraction level, and not all processes within were worked out. They accepted the problems that would occur during the process, but were eager to solve them directly. When completed an evaluation moment was chosen to assess the problem, and determine how they need to approach it the next time the problem ensues again.

### *7.4.3 Interview results: Evaluation*

In this section the Matrix tables are evaluated.

In Table 7-4 Matrix Question 1, it is assessed whether the organizations see their assets as important enablers of value creation, and have structured their organization as such to support it. The table shows that there are large discrepancies between municipalities regardless its size. It can't be said that the large municipalities (G) perform better on this criteria than the smaller ones (K). There are always outliers. However, the main criteria in this question is whether there is a strong AM leader supporting the organizational change in the municipality. Of course it can be assumed that the larger municipalities have the natural advantages in the number of people, and available knowledge to create or attract such leader.

In Table 7-5 Matrix Question 2, it is assessed how the maintenance measures are determined looking back at objectives, performances, inspections, resources. Key focal point is on how municipalities make their maintenance decisions based on available data (reactionary or preventive). The table indicates that the majority of the municipalities base their maintenance decision on substantiated asset information, and are able to largely execute preventive maintenance activities. However, the cities lacking on this criteria are in a transition phase wherein alternatives are sought to replace their current asset data system. They are not yet able to retrieve useful information of their systems to execute preventive measures.

In Table 7-6 Matrix Question 3, an assessment is done on what the municipals strategic objectives are, and what their place is within the maintenance process. The table shows that the majority of the cities have made attempts to translate the strategic objectives into meaningful information. There are attempts made to create a line-of-sight from strategic to operational level. Nevertheless, some have scored lower on this criteria as they believe merely conforming to performance criteria is sufficient.

In Table 7-7 Matrix Question 4, the question is asked on whether municipalities are aware on how an asset could impact the whole asset network, and how it could influence the value creation positively or negatively. Surprisingly, the majority of the municipalities score low on this criteria. The reason given is that they are still unaware and unable to really work in 1 data system with linked data in a practical way. This is due to difficulties in communication cross disciplines, but also due to the new mindset that is needed to understand how assets can be connected in the system.

In Table 7-8 Matrix Question 5, the question is asked on whether municipalities approach functionalities of a system the same way as the technical requirements of the system. This question resulted from the line-of-sight model by Huerne and Willems (2011, p. 13), and §6.5. The results from the municipalities shows that they are aware of the potential of a functional approach within Asset management. Currently, they have approached functional requirements unstructured in the way that they are not more than a list of specifications. Moreover, they see the way they maintain their assets now as sufficient, and do not regard this step as crucial.

In Figure 7-1 below, the 5 matrix tables are merged, and a bubble chart is created to give an indication on how the municipalities score in each matrix question. It should be taken as the overall Asset management level, with regards to the line-of-sight, within municipalities in the Netherlands. The graph shows that municipalities are definitely aware of the importance of linking strategy to activities (MQ 1 to MQ3). However, the practical understanding, and implementation of AM on the impact on the asset network (MQ 4), and functionalities (MQ 5) remains a challenge for the majority of the municipalities. The conclusion can be reached that there are positive trends noticeable towards full line-of-sight AM. The basics is present, but multiple iterations are required to refine, redefine, and improve the fundamentals of their Asset

management processes and system. These improvements are predominantly required in the tension field between strategic and tactical level.

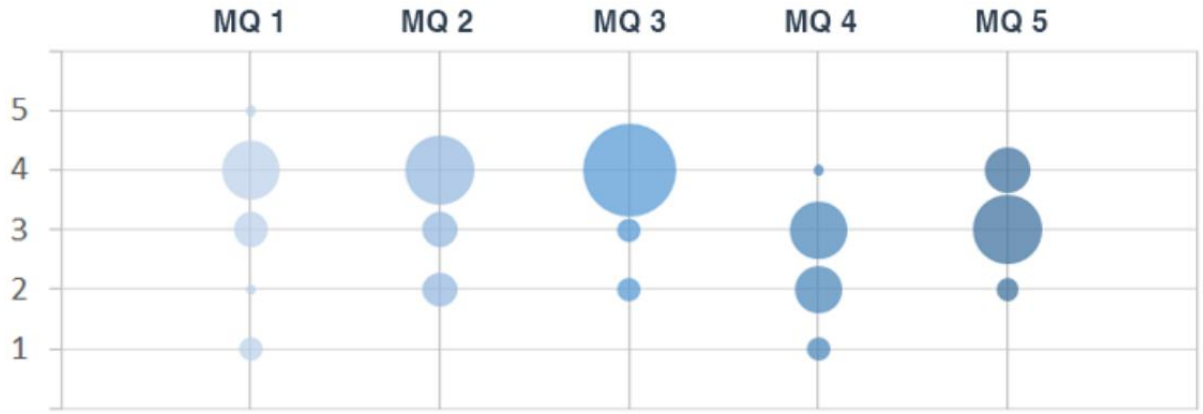



**Figure 7-1 Bubble chart matrix ratings Municipalities for the Matrix Question 1 to 5**

## 7.5 Summary

An advantage municipalities have in comparison to private parties, is that municipalities have a natural division between strategic, tactical, and operational level. The Municipal Secretary is often appointed as the Asset Owner, while actually the political body consisting of the Executive board, and Council is as well. However, interviewee 6-60 mentioned that the Council is not inclined to see themselves as the Asset owner. This might be one of the causes of the lack of linkage between the strategic level and the tactical level within municipalities.

Table 7-4 shows that the development of Asset management within the municipalities differs greatly. This table refers to the question whether municipalities acknowledges the importance of value creation with their assets, and the extend to which their organization is structured around this concept. It shows that the size of a municipality does not indicate the implementation level. There are good trends visible in outsourcing maintenance through area-based contract forms to the service provider. However, there is a division noticeable. One side is eager to implement AM, while the other is stubborn and rather waits until is it required (through a higher governmental layer, or through the Asset owner).

When asked about the strategic objectives, municipalities acknowledge the existence of the strategic objectives and usually translate them into the required measures. However, with such approach the main emphasis lies on the asset itself. It doesn't lead to value creation, as it is merely focuses on maintaining an asset to a specific performance level. Other municipalities use an intermediate step by defining corporate values, and prioritize the maintenance measures using a corporate value matrix (Appendix G). It is a step towards the right direction, but even so "*the relation between the strategic goals, performances, activities, resources, and the operational activities are insufficient connected"* (Interviewee 7-63).

An extended step within the line-of-sight is the existence of the component functionality (Figure 1-4). It argues that a functional structure could be the missing link between translating objectives to operational measures. However, in Table 7-8 it is shown that none of the cities use the

approach as elaborated upon in Figure 13-8. They mentioned that this step is currently too far, and is currently not sought after (Interviewee 7-63).

Municipalities have a similar ambition in that they wanted to improve maintenance as the state of their assets were declining, there was overdue maintenance, a shift needed to be made towards risk based maintenance, substantiate their needs towards the political body, less capacity available, reduced funds, and to make the organization more transparent (interviewee 2-22, interviewee 5-54, interviewee 6-59, interviewee 7-69). Especially, the Medium and Small municipalities stated that they were not specifically after Asset management implementation, but rather were looking for practical tools, and processes to make their maintenance more efficient. The emphasis is on efficient, as the Asset Owner does not steer on effectiveness (interviewee 7-64).

The majority of the big municipalities have chosen to adopt Asset management as their primary process. The smaller and medium ones are more cautious, and attempt to take over specific components. It results in a higher efficiency, but not in a higher effectiveness. Effectiveness is determined based on the extent the strategic goals are fulfilled. Neither of the municipalities, with or without AM implementation, are currently able to do that. Considering the state of AM within some municipalities (i.e. 4, and 9), the transition towards Asset management should firstly focus on gaining support among the employees, clarify the internal and external drivers, and having a good vision. A functional view such as the author has mentioned a number of times in this report, should be sought after when it is a proven concept. Municipalities have limited resources, and are cautious. They need to implement ‘Asset management’ in manageable stages, starting with the organization.

# Chapter 8 **Empirical research results at the strategic level**

*This chapter contains the results from the semi-structured empirical research. The difference with Chapter 7 is that the interviews conducted in this section follow a fixed set of questions, which were formulated as an extension on the previous chapter in mind. Moreover, the interviews are carried out solely with practitioners on a strategic level within municipalities.*

*Nevertheless, the goal of the chapter is comparable to Chapter 7 ; answering Sub-question IV, and V.*

*Sub-research questions (see Chapter 9 )*

*IV. Which key factors could hinder the transition process for municipalities?*
*V. What are the fundamental causes of those factors?*

## 8.1 Chapter methodology

The semi-structured interviews in this chapter are conducted supplementary to those in Chapter 7 . The intention of this chapter is to find an answer for the research questions IV, and V based on input from the strategic interviewees. Through an interview on the usage of strategic goals, and its impact on the maintenance decisions in the lower layers of the organization, it is determined how the municipality (from the perspective of a strategic role) views its current maintenance process, and what is required to improve upon it (towards Asset management). Based on this notion the hindering transition factors are reassessed. Moreover, the answers are cross-evaluated with the interview results from the corresponding municipality in Chapter 7 .Therefore, the interviewees in this chapter operate exclusively on a strategic level within the municipality, and are from a municipality already interviewed in the previous chapter (see list Appendix B, section I).

In order to answer the research question "*how to contribute towards an effective Asset Management transition process for municipalities*" the interview contains three broad themes; (1) hierarchical levels, (2) line-of-sight within maintenance, to determine the municipalities understanding of AM, and (3) its implementation, to gain knowledge on how to smoothen the transition process towards AM. In this section the emphasis in this chapter lies on determining the line-of-sight within municipalities; how the corporate values are implemented in the operational activities.

## 8.2 Interview protocol

Referring to Figure 2-1, the research model, the interview protocol is composed based on the theoretical framework established in Chapter 3 , Chapter 4 , Chapter 5 , and Chapter 6 . The interview protocol is used as an aid to support the semi-structured interviews with the municipalities.

Here a semi-structured interview approach is adopted. According to PSC (2009, p. 2) a structured interview has the advantage that it can be evaluated systematically, as each interviewee is asked the same questions. However, due to the preset of questions, they cannot be altered during the interview and the researcher is unable to deviate from the prescribed interview path. The stated disadvantages are not considered to be crucial at this stage, as multiple unstructured interviews were conducted in a former session. A semi-structured protocol follows a similar approach, but instead of pure closed-ended questions, a mix is used resulting in a more flexible interview protocol. Another advantage of structured closed-ended interviews

is that data can be analyzed in a quantitative manner. However, due to the sample size in this chapter, this is not attempted. Therefore, an semi-structured approach is opted.

The semi-structured interview questions follows the proposed guidelines by Jacob and Furgerson (2012); research guided questions, script, mixed open ended, expansive questions, willing to revise on the spot, and keep the interview short. With these points of interests in mind, the structured interview protocol was developed (see Appendix B, section IV). An important difference with the interview protocol in Chapter 7 , is that there is less emphasis on identifying the technical maintenance process within the municipality, but instead revolves more around the social side of the line-of-sight; How they as strategic leaders are managing the maintenance process. This change in approach follows the initial conclusions drawn from theory, and the empirical research completed at this stage of the process.

## 8.3 Interview sample

In addition to the 13 interviewees in Chapter 7 , this chapter consists of an analysis on the semi-structured interviews with 3 interviewees on a strategic level (Appendix B, section II). The 3 interviewees represent 3 large sized municipalities, having more than 300.000 inhabitants, and have a pivotal strategic role in the organization ranging from managing director, chief management of public space, to chief civil engineering. Given the time, and budget constrains of this thesis, it was not feasible to conduct additional interviews for all municipalities stated in Appendix B, section I. Assuming more time, and access to more strategic interview participants, a better answer on the sub-research questions could be given.

It is acknowledged that the gathered information in this chapter, based on interviews with the 3 interviewees, is not valid on its own due to the small sample size. However, as interview partners were asked within municipalities that were already interviewed, data can be used supplementary to the unstructured interviews.

## 8.4 Method of analysis

The interviews are transcribed in Dutch in Appendix C, section II. The interviews are semi-structured, and therefore a direct comparison between the question answers of the interviewees is possible. Moreover, conclusions drawn from the interview results are also compared with their own municipality analyzed in Chapter 7 .

Due to the sample size, the analysis in this chapter follows a similar pattern as the previous. Data is transcribed in Appendix C, section II, thereafter a simple reference system is created by numbering each answer of the interviewees. It consists of a composition of the interviewees number and the numbering; e.g. *Interviewee St.1-14*, referring to Interviewee St.1 paragraph 14. A quote-research is then followed to compare the answers of the three participants. In addition a direct evaluation with their corresponding municipal colleague is given, and a conclusion is drawn.

## 8.5 Interview results: Strategic roles

1. **The strategic role of Asset owner within the municipality, and the responsibilities.**

Questions regarding the hierarchical roles within Asset management were asked, to further clarify the role responsibilities within the municipal organization, emphasising the strategic role of the asset owner. This data is used to complete the section on the practical municipal structure in § 6.3.

In § 1.2 a difference was recognized in Asset management roles, ranging from Asset owner, Asset manager, to Service provider. However, with a critical mindset one could argue what the practical purpose is of such a division in an organization. Croon (2011) stated it is a real-world issue whereas some organizations have formalized these roles, some are aware, but are yet to see its usefulness, and some are clueless. Answering the practicality of it, Croon (2011) argues that it "*gives focus, and clarifies the desired objectives*". In the same article he summarized a number of drawbacks this division could have, such the organization needs to restructure the allocation of budgets and reporting channels, it encourages inequality, and it leads to finger pointing and discourages proactive attitudes (Croon, 2011). These statements suggest that in order to facilitate the AM process, adverse impacts are created in the organizational culture.

Despite the fact that the natural municipal structure facilitates the usage and distinction in hierarchical roles (see Figure 6-1), two of the three interviewees' state that the role divisions are acknowledged, but not formalized (interviewee St.1, interviewee St.3). In practice, the responsibilities of owner, manager and sometimes those for service provider are harder to differentiate. Interviewee St.1-103A argues that throughout the whole organization multiple Asset managers can be assigned, making it a confusing concept. Moreover, in practice the asset owner is simply interpreted as those who have the final responsibility. In the political body that someone is the Executive board Mayor and Alderman and the Municipal council (Interviewee St.1-103B, interviewee St.2-115A, interviewee St.3-127). In the Government administration that someone is the Municipal Secretary or the Managing director in a management model (Appendix J, section VII), Interviewee St.1-103A). However, de political body is not actively involved in the maintenance process (Interviewee St.1-103C). As a result, in practice, a shift of responsibilities occurs to the lower levels, resulting in a fragmented distinction in hierarchical roles within the organization. This is especially noticeable with Interviewee St.3-127 who states that in his organization the whole Government organization is seen as the asset owner, whereas employees on both strategic, as operational levels take on asset owner tasks. The latter is done purposely to avoid "*creating distance*" between employees (St.3-136). This is in line with the observations made by Croon (2011) who identified it as a potential harmful impact on the organization culture.

What all interviewees' describe is that it is important to acknowledge the responsibilities of the hierarchical levels on a high abstraction level, but should avoid recklessly taking on definitions and concepts as it could lead to a limited perspective, and expectation. The whole Government organization needs to look beyond their own role, and enter a dialogue to create an environment of interaction (St.2-115C).

### 2. Influence of strategic goals in maintenance decisions as a function of value

According to interviewee St.1-103E, the municipality pursues public value of residential satisfaction. Each area and sector a municipality is responsible for, should operate leading to improved satisfaction, and thereby creating value. Depending on the department this public value is decomposed into strategic objectives determined by the political body (Interviewee St.1-103D, interviewee St.2-115B, interviewee St.3-127). As such the strategic objectives clean, safe, and intact are important objectives for maintenance, but are not the leading principles within every maintenance department. Interviewee St.1-103E states that for sewerage the optimal fluidity is regarded as the strategic objective. The interviewees acknowledge that defining strategic goals are means to make a substantiated decision, supported by a frame of asset data (interviewee St.2-115C).

The extent to which the strategic goals influences the decision making of employees within the whole organization is answered by the interviewees in line with the line-of-sight. It is not expected that employees on a pure operational level are aware what the strategic objectives are, and how their activities specifically contribute towards this overall view, but "*they are aware*

*of the broader perspective*" (St.1-104). Everything that is done on the lowest levels relates to the decisions made by the aldermen (St.2-116).

How the municipalities currently ensure the strategic objectives are met is through a chain of reports. Interviewee St.1-105 mentioned two distinct cycles; the government cycle, and the internal (government administration) cycle. The former is a biannual report that accounts the realisation of the organization, emphasising meeting the goals and financial resources. The latter are quarterly reports with the departments that likewise include the realization, goals, and resources. However, interviewee St.2-115C argues that the maintenance actives are not always well explicitly traceable towards the strategic objectives, he refers to the multiple intermediate translation leaps. For instance, "*it is problematic to translate a maintenance activity, such as periodical cleaning of wooden bridges, to economic rational maintenance*" (Interviewee St.3-128). Asking whether the current report process is adequate to determine the exact value creation of the municipality, the participants admit that it is still far from explicit monitoring, and measurement, but there is a conscious concern (interviewee St.1-106).

### 3. Improving the maintenance process, and the transition towards Asset management.

All strategic interview participants recognize the shortcomings and limitations of the current maintenance processes in their respective municipality (Interviewee St.1-111, interviewee St.2-123, interviewee St.3-133). Interviewee St.1-108 states that the existing maintenance approach is primarily controlled from a tactical perspective. It is a budget driven maintenance approach whereas activities are mostly determined from a financial perspective (interviewee St.2-120). In order to control it strategically, "*maintenance should be related more to the whole urban assignment*" (Interviewee St.1-108). However, according to Interviewee St.3-133, it should be prevented that methodologies and approaches are adopted that have a sound theoretical basis, but wouldn't directly improve value for the citizens in the public space. For instance, the theoretical model on functionality shown in § 6.5 had potential to bridge the gap between strategic objectives, and the maintenance activities through function fulfillers. This mindset is in line with the line-of-sight model presented by Huerne and Willems (2011, p. 13) (see Figure 1-1). Interviewee St.3-134 argues that new approaches should be screened on its usefulness, as each change has major implications on the work processes, but more importantly on the structure of the asset data system.

In addition, the interviewees agree that Asset management as a methodology should and is further developed within the organization to improve the maintenance process (Interviewee St.1-113, interviewee St.2-125). Not all agree upon the terminology Asset management, as interviewee St.3-135 regards it as an umbrella term. This is common perception practitioners have on AM, as mentioned earlier in § 1.2. However, important within AM is that deliberate decisions can be made, based on objective asset data. The latter is identified as the most crucial by interviewee St.3-135, interviewee St.2-125, and interviewee St.1-111. "*Asset management is not something new, but an aid to make better decisions*" is said by interviewee St.2-126. Whether one defines the approach as AM or not, the objectives and means to improve the maintenance process within the municipalities are identical. It starts with structuring the asset data, thereafter means to monitor the condition of the assets are adopted, and ultimately this is used to substantiate the decision making process, focusing on the value creation of citizens satisfaction (interviewee St.3-135).

Important factors mentioned to facilitate the transition process towards Asset management are according to interviewee St.1-114, the persuasion of the employees in the process by *"telling the story*". This is shared by interviewee St.2-126, who brought up the importance of an orientation module as a solution. Interviewee St.1-114 mentioned another factor which is making the end result visible. This can be interpreted as setting the start-, and end state in Lewin's change theory (§ 5.3.1). The last factor mentioned by interviewee St.1-114 is that the transition

period should be prolonged over many years to integrate the new methodology permanently. Interviewee St.3-136 approaches it more from an organizational perspective, and argues that short lines between departments is a necessity. He argues that policy creation needs to be organized closely with the operations. Thereby, a strict division between asset owner, asset manager, and service provider is not desired. Instead, departments, and employees could carry out multiple roles.

The stated factors to further the implementation of Asset management do not revolve around optimizing the technical side of the process, but is organizational. However, there is one crucial aspect for which asset data needs to be structured. It is the underlying factor of the whole process.

## 8.6 Summary

In this chapter additional interviews were conducted with interview participants on a strategic level. Three themes were reassessed: the hierarchical levels of Asset management within the municipal organization, the line-of-sight, and the transition factors.

In practice the hierarchical roles Asset owner, asset manager, and service provider are not always adopted in a municipal structure (interviewee St.1, interviewee St.3). Some purposely circumvent the formalization of these roles as it could "*create distance*" between the employees (St.3-136). This disadvantage is also recognized by Croon (2011), who summarized that it could encourage inequality, could lead to finger pointing, and discourages a proactive attitude of employees. All the interviewees acknowledge that the responsibilities of the hierarchical levels should be understood, but employees are required to look beyond their own role, and enter a dialogue to create an environment of interaction (St.2-115C). The hierarchical roles are interpreted as a necessity of creating policy, translating the policy into a maintenance plan, followed by its execution. Differentiating employees based on this trichotomy is in a practical sense insignificant, as some could assume multiple responsibilities. As long as a healthy interacting environment can exist within the organization, and communication is encouraged, the structure is adequate.

The strategic line-of-sight within the municipalities is ensured through a chain of reports. The interviewees argue that through this chain, it is explicitly shown how objectives are met (Interviewee St.1-103D, interviewee St.2-115B, interviewee St.3-127). However, when asked how much value is created, the participants admit that it is still far from explicit monitoring, and measurement, but there is a conscious concern (interviewee St.1-106). Interviewee St.3-128 mentioned that "*it is problematic to translate a maintenance activity, such as periodical cleaning of wooden bridges, to economic rational maintenance*". It shows that according to the strategic interviewees, the current report process is sufficient enough. Nevertheless, future developments are sought wherein the exact value creation can be determined.

How the maintenance process can be improved is agreed upon. All the interviewees mentioned the asset data system as an important factor to build upon for Asset management. In addition, within a transition process, the organization should focus on "*telling the story*" in order to create support among the organizational employees. Other factors mentioned follow a similar pattern in which predominantly social factors are mentioned. This observation is in line with the results from Chapter 7 .

# Chapter 9 **Intermediate conclusion - Research questions**

*In this chapter the research questions I to V, are answered based on the previous chapters (see research model Figure 2-1)*

**SQ I. What are the cornerstones of Asset management?**

There are many definitions on Asset management varying based on the industry it is used in. There even exist different definitions among researchers in the same discipline. However, from a fundamental standpoint, the definitions are quite similar in meaning. They all regard Asset management from an engineering perspective with tangible assets. It describes the "*core role in life – both caring for, and making best sustainable use of infrastructure*" (Woodhouse, 2003, p. 2). This interpretation is the leading view on AM for physical assets, and in a sense overlaps with the definition used in the NEN-ISO 55000.

To identify what Asset management is, the cornerstones are identified. First of all the purpose to implement Asset management is to (1) balance the costs, risks, and performance with a company-wide strategy, (2) align the corporate objectives with the asset-related spending, and (3) making decisions based on a rigorous and data-driven process (R. E. Brown, 2010, p. 306). The purpose reveals that Asset management is a process approach. Important to acknowledge is point 2 which states that it attempts to align the corporate objectives with the asset-related spending. Implicitly Asset management concerns the line-of-sight (Figure 1-4). In the introductory section of this thesis, multiple references were made to the line-of-sight model developed by Huerne and Willems (2011). How Asset management is described in the NEN-ISO 55000, thus what is needed, and not how one could implement Asset management, is the correct approach. Asset management is not the sum of the core functions (Figure 3-4), as merely having these in place is *not* Asset management. It is a requisite, but more important is that each decision is made based on a thorough data-driven process (point 3), and there is an explicit linkage throughout the whole decision making chain. A strategic objective forming the boundary condition is vital.

Having a solid Asset management process in place means that one could balance the costs, risks, and performances (point 1) based on a higher strategic objective due to the linkage in the decision making process. The impact is that a competitive advantage is gained, whereas the effectiveness and efficiency of spending is greatly improved. An analysis on the impact of Asset management within the organization has shown that the organization is predominantly affected on a social level. This validates the statement made previously in which the line-of-sight is more important than merely having the core functions of Asset management in place. In a change process towards Asset management, more emphasis should therefore be put on the organization and employees, than on the implementation of the core function and Asset management system. The latter are only supporting functions for the Asset management behavior and understanding of the organization.

**SQ II. What are the key factors required for the Asset Management transition process?**

When we look at the transition process from a change management perspective, the following factors are identified.

I. ***Identification of External and Internal drivers*** – It refers to the root cause of the change. Analyzing the start state exposes the weakness of the organization in the current environment. Only by clarifying and understanding the problem, a change process can be set up. The Lewin and Lepitt Change models focus on this problem identification.

II. ***Clarifying the need of change*** – This factor refers to balancing the driving and resisting forces. Employees are only willing to cooperate with the change process when it is clear why the current situation is obsolete and the new state is desired. The role the employee has in the new situation also has to be communicated, as it could affect job security or compensation.

III. ***Vision*** – The vision is the strategic objective in change. In Pettigrew's model it is mentioned in the content dimension. A clear vision a goal set out by the change leader is supportive for all decision making during the transition.

IV. ***Understanding the context*** – Each organization is different. A change process is only effective for a particular organization, during a particular time horizon, towards a specific end state. Therefore the change leader needs to gain top management support, negotiate, and train employees. Keeping it in mind smoothens the change process, and minimizes resistance.

V. ***Clear process*** – In a change process employees often complain about the ambiguities and unknowns. Therefore, the change process should include a clear plan along a certain time frame with clear milestones.

VI. ***Change roles*** – Lippitt mentioned that in *Phase 5* the change agent adopts an appropriate role, so that stakeholders are aware what he can and cannot expect of him. The same is valid for all employees. What is the position of the employee in the change, and who is responsible for which decisions.

VII. ***Communication*** – This factor is always a vital factor, regardless during change. In order to mitigate misunderstandings good communication is required. Often efficiency gains can be made by improving the communication channels, and incorporate decision making processes in a data system.

VIII. ***Leadership*** – Leadership is one of the most important factors during change. He is responsible for the vision, process, and most decisions. In Lippitt's model he is referred to as the change agent.

IX. ***Refreeze*** – The final step during a change process is refreezing the end state (Lewin's Change model). The change needs to be adopted, and embraced by its employees. Old habits needs to be unlearned before it the organization unconsciously transitions back to the old start state.

X. ***Core functions*** – The core function (Figure 3-4) is a supportive infrastructure, and is the only factor specific for Asset management. It includes functions needed in an AM system, but must be seen as aids to implement the strategic line-of-sight.

### *SQ III. How is Maintenance organized within a Municipal organization?*

The maintenance line-of-sight (Figure 6-3) represents the maintenance process followed by the municipalities interviewed. The structure of a municipal organization is largely the same, whereas the separation lines between the strategic, tactical, and operational levels are identical. The differences are instead found in the way organizational objectives play a pivotal role in maintenance considerations. Organizations that found those to be important usually adopted a form of corporate values, and a corporate value matrix to translate the organizational values in practical objectives. Moreover, a vital distinction is on whether the municipality is identified as a traditional maintenance municipality (beheergemeente), or a controlling organization (regiegemeente). In the latter all the executing activities are outsourced to the market parties usually using area-based contracts (interviewee 5-48).

In the maintenance line-of-sight there is a practical decomposition of public value towards maintenance execution. Compared with the line-of-sight model in §1.3 adopted from Huerne and Willems (2011) , there is a lack of functional structure within maintenance. Municipalities do not anticipate problems when a functional structure is lacking in the maintenance considerations.

Problems currently lies in the implementation process of Asset management, and in particular conveying the message of strategic linkage of objectives and maintenance activities (line-of-sight). As such the practical implementation of Asset management within municipalities is sufficient as long as there is a sound understanding of the fact that maintenance activities should originate from strategic objectives. In addition the political body (Council), to which the Executive board has to report, does not ask for a more thorough substantiation of how the maintenance activities benefit the organizational objectives, therefore maintainers see no need to adopt a system perspective in Asset management.

***SQ IV. Which key factors could hinder the transition process for municipalities?***

From the empirical research the following key factors hindering municipalities to fully transition towards AM are:

I. ***Demands of the Asset owner*** – Start of change is usually the result of an internal or external demand. In the case of municipalities the Council is the Asset owner. However, this political body is mainly concerned with short-term results and financial gains. (*Interview question 1, and 7*)
II. ***Integration of departments*** – Municipalities are responsible for many social issues. To support it, the organization consists of many departments. AM requires an organization wide approach. As not every department is concerned with maintenance, and it is not always known who is responsible for what, communication between departments are lacking. (*Interview question 2, and 4*)
III. ***Related change processes*** – AM doesn't require just 1 change process. It consists of many others such as becoming a controlling organization (regiegemeente), and necessity to adopt new contract forms. Implementing them all at once puts a strain on the organization as it still has to function during the change. (*Interview question 3*)
IV. ***Resistance of employees*** - The divers AM implementation levels among the municipalities partially depends on the employees. Some are very eager while other are stubborn. (*Interview question 7, and 8*)
V. ***Unambiguous objectives*** – A common pitfall within AM is how the organization deals with their strategic objectives. Objectives are ambiguous and are hard to make substantiate and translate them into practical measures. (*Interview question 2, and 3*)
VI. ***Reliable data*** – Data is one of the most important components within AM. However, the way it is incorporated in a data system determines whether the correct information ca be retrieved. AM requires that there are relations between data elements. However, municipalities struggle with this view as it is new. (*Interview question 4, and 7*)
VII. ***Unknown concept*** – Interviewees have stated that AM is one of the many terminologies used in maintenance. However, what it is exactly is not indicated. They approach the maintenance from a practical standpoint, and as a consequence end up with a process that is not interlinked, but still does comply with the wishes of the Asset owner (See also point I) (*Interview question 8*).

**SQ 5. What are the fundamental causes of those factors (see SQ IV)?**

The hindering factors for municipalities to the full transition of Asset management can be divided into two categories; technical, and emotional. These categories were also identified in interview question 7 (§7.4.2).

*Emotional*

I. ***Demands of the Asset owner*** – The demands of the Asset owner plays a major role in the transition process. The Asset owner needs to be self-aware of the needed change in maintenance, or a strong AM leader should pursue him to do so (*external and internal drivers*). Table 7-4 showed that municipalities with a strong AM leader scored higher in areas of Asset management than those who refute the need the need of it. Without the leader it is hard to *clarify the need of change* towards the organization, and formulate an end-state with a *vision*. As a result the (potential) change process stagnates.

II. ***Integration of departments*** – Municipalities in the Netherlands are responsible for a whole range of (social) issues. Moreover, the size of their asset network is relatively big, and are managed by multiple departments. However, a factor important not only during change, but also in general is *communication*. The departments in the municipalities are unable to efficiently communicate with each other as the current asset data system does not support this extent of cross disciplinary integration yet (Table 7-7). Moreover, the *change roles* factor indicates that employees and departments during and after a change process, should be aware of their role within the organization. They need to know what is expected from them and what they can expect from others.

III. ***Related change processes*** – A change process requires a lot of resources both in time, costs, and human capital. Therefore, municipalities are reluctant to blindly follow the newest trend on maintenance. Moreover, interviewee 7-68 has mentioned that their AM transition process has taken years. It indicates that following through with this process requires determination from start to finish. This refers back to the need of a *leader* who could support this process simultaneously with other change processes, and inevitable changes underway.

IV. ***Resistance of employees*** – The employees are naturally afraid of change as there ambiguities, and unknowns. These characteristics are predominantly present in employees at the tactical and operational level of the organization. Interviewee 8-75 mentioned that there is an existing culture, and a change creates problems in the balance of the organization. People are afraid of losing their jobs, and their role in the new structure. On the strategic level, resistance is often found in unknowns in costs and benefits, with an emphasis on costs. A *clear process* in change, a strong maintenance ambition (*vision*) and a clear start and end state set out by the change *leader* could help in mitigating some of these problems.

*Technical*

V. ***Unambiguous objectives*** – Municipalities struggle with the translation of strategic objectives into workable components. Reasons given is that the level of abstractness between the strategic objectives, and asset management objectives (i.e. quality levels) isn't always evident (interviewee 2-14). A proposal is made to the municipalities in how a functional approach could aid in this translation process (Table 7-8). However, a more advanced step than that they have implemented now is not sought after. The problem is that without a clear translation between objectives and maintenance activities, the creation of value can't be determined. This is one of the fundamental goals of asset management (referring to the second point of Brown in SQ I).

VI. ***Reliable data*** – Municipalities use a vast range of different data systems for handling their assets. AM requires that decisions are made on correct, and up-to-date information retrieved from the data system. However, in practice this is

hard to manage. Interviewee 3.B-33 mentioned that not always colleagues follow protocol and fill in all data. Moreover, the new data system in place is not used organizational wide as some departments still employ their own systems (Interviewee 3.B-33). The reason for the latter could be seen when we cite the responsible maintainer of the excluded department. Interviewee 3.A-32 mentioned that they are still busy writing down the maintenance processes and tailoring them to the organization. Using an asset management system, while the maintenance processes, and the protocols for data is yet to be determined is asking for trouble. It results in corrupted data, and makes the transition to the new system more complex.

VII. ***Unknown concept*** – This aspect is also mentioned in the starting stages of the thesis; what is Asset management? An attempt is made to identify the *core functions* representing the AM process. However, it appeared that these core functions are integrated differently among the municipalities. Just conforming these does not indicate Asset management. Instead the rationale on maintenance decisions, and the way asset data is structured and retrieved, and costs, risks, and performances are balanced better reflect the state of AM within the municipality. Nevertheless, the core functions are still required in the basic form, and assists in *clarifying the process*.

Looking back at the emotional hindering factors within municipalities, these can be traced back to three distinct factors mentioned in **SQ II.**

- Vision
- Communication
- Leadership

It seems that a successful transition towards Asset management depend on a technical factor to determine what the start and end state is of the change, but more importantly on a balance between the vision-communication-leadership triad. When these three factors, supported by the technical factors, are properly organized and understood, a successful transition process follows.

# Chapter 10 **Transition model**

*This chapter incorporates a model that could aid municipalities to smoothen their transition towards Asset management. This chapter can be seen as the answer on sub-question VI.*

*Sub-research questions*

*VI. How can we facilitate the transition process towards Asset management for municipalities?*

## 10.1 Introduction

In the previous chapters the state of AM within the Dutch municipalities were assessed. Concluded was that the maturity of the municipality wasn't related to the size, but rather to the emergent AM leader, and their vision on the process. There was however a natural advantage for the bigger cities in that they are more competent in attracting knowledge, and potential employees to their organization.

In this section a transition model is formed that addresses the key factors important for municipalities, and the key components in the AM process. It must be observed that the level of Asset management is technical, while the needed changes mostly reflect social components.

GFMAM (2015, p. 7) stated that an organization performing at the highest level of Asset management has the following characteristics:

- They deliver outcome that meets the need of the stakeholders
- They are continuously improving
- Leadership and commitment is visible on all levels of the organization
- All disciplines in the organization are integrated
- Everyone is focused on delivering great value for the stakeholder
- There are appropriate analysis methods and decision-making methodologies in place
- They are able to demonstrate the best value solution, and quantify the impact of suboptimal options
- They are aware of their position compared to competitors or peer groups

This short list reveals that the justifications made throughout the whole report aligns with the views of high level Asset management. The assessment of the maturity of Asset management within organizations is often desired, especially as it can be used to determine their position in relation with their direct competitors. Various leading organizations in the area of Asset management, such as the Institute of Asset management, have developed Competence frameworks to determine the required competence of the employees in the AM organization. In addition maturity models emerged to rate the organization's AM competence based on a number of criteria. K. Brown, Keast, and Mahmood (2015), on behalf of the Asset Institute, have created a model called the "*Asset management capability maturity model AMCAaMM"* which relies on the answers of organizations in 25 different process areas to determine their current AM capabilities (theory on the capability maturity model is appended in Appendix J, section XI). This model is useful in this research to determine how a municipality could manage his transition process in order to further the organization on the maturity scale. As it was determined in Chapter 7 , there is a notable difference in range of AM implementation level between the municipalities.

## 10.2 Asset management transition model

In the creation of a transition model the Asset management maturity levels are adopted from K. Brown et al. (2015), the conceptual model of change by Devi and Charan (2013, p. 93), the core function model in §3.6, and the identified key factors in Chapter 9 .

These components are used as input in the Asset management transition model for municipalities. It should be noted that the model is created on a high abstraction level, and more importantly the ratings in the matrix tables (Chapter 7 ), do not directly correspond with the maturity levels in the transition model. The matrix tables were created *only* to assess the municipality's understanding of the line-of-sight within Asset management. The overall maturity level of the municipalities in Asset management should be determined based on a more rigorous research including strategic documents, rather than only an interview with 1 interview applicant per municipality. It was concluded from the empirical research that municipalities understand the importance of the line-of-sight, however there is still a need for additional improvements before the Dutch municipalities are regarded as value focused maintenance (CML 4) organizations, as it demands a more explicit organizational wide link between strategic objectives and maintenance activities.

The Asset management transition model is shown in Figure 10-1.

### *10.2.1 Transition model explanation*

Based on § 7.4.2, whereas the interviewees were asked to describe their method to improve their maintenance process, it was observed that municipalities were aiming for identical goals; correct information, ability to talk with the political body, increased effectiveness and efficiency of their maintenance process, and the ability to make more considerate decisions. The latter is dependent on an assessment to maximize the value within the municipality. In other words, "*…its relationship to the active goal*" (Markman & Brendl, 2000, p. 98) (also see Appendix J, section II) In conclusion it can be noted that municipalities strive for improved maintenance, and the goals they strive for are covered by the Asset management methodology. Therefore, the transition model revolves around the change process towards Asset management.

The Transition model shows that the change process towards full Asset management implementation requires time. Therefore, a separate change process is created between each corresponding stage of the '*AM maturity model'*. It indicates that the situation at that point should be reassessed to identify the current organizational context, regain support of the employees, and rearrange the change roles. These were identified as one of the '*success factors of change*' as part of sub-research question II. However, in sub-research question IV and V, the change factors hindering the municipalities were also evaluated. A distinction was made between *emotional* and *technical* factors. The emotional factors were argued to be the most crucial factor of success, as they have the most impact on an organization (§ 4.5). This is validated by the interviewees in Chapter 11 , who have commented on the core function model, key transition factors towards AM, and the transition model itself. Based on the findings it was concluded that the emotional factors can be traced back to 3 fundamental factors; Leadership, Vision, and Communications. In the transition model these factors are given an alternate color to indicate the importance. Moreover, it is important that the Leadership, Vision, and Communication should be present at all stages throughout the process and should be robust, stable, and clear. Any inconsiderate changes in composition of these three factors could directly influence the other success factors leading to a stagnating process, unambiguity's, and failure.

In Figure 7-1 a bubble graph was developed to visualize the interviewees understanding of the line-of-sight, and to assess whether the strategic to operational line was followed explicitly in the municipalities maintenance process. It was shown that the maturity of the line-of-sight within

municipalities differed greatly. Further questions on maintenance improvement in § 7.4.2 showed that the focal points within the change process of municipalities that differed in Table 7-8 varies as well. The differences are included in the transition model as important '*objectives'* the municipalities need to focus on at this stage. For example, interviewees who answered the line-of-sight questions leading to a low rating on the scale (Table 7-8), first need to focus on getting support of the Asset owner, identify the need of AM, and clarify the concept of AM among the employees. A low rating indicated that not all employees are aware of the strategic importance of the organizational objectives in the maintenance decisions on all hierarchical levels. The next objectives in the AM change process are emphasized objectives for that stage of AM.

The '*Asset management transition*' is a practical roadmap to reach the AM change objectives. These can be followed by municipalities to facilitate the change. The last category are the '*core functions*' of AM. In § 3.5 these core functions were identified as the most crucial functions within an Asset management process. Like the objectives in the transition model these are functions on which the change organization needs to focus during that stage of AM. These core functions fit the core functions model created in Figure 3-4.

### *10.2.2 Transition model readability*

The transition model can be used to facilitate the change process towards AM within municipalities. It forces the organization to assess the AM maturity of the organization, define the start and end goal, and determine the change objectives to meet during the process.

As one interviewee has mentioned the change towards Asset management actually revolves around the social factors of change (Interviewee V.6). Moreover, the interviewee stated that in a model it is vital that the municipality is able to arrange the needed components themselves, as each municipality is unique. Besides, we need to acknowledge that also the technical components are crucial. However this can be concluded into a simplified version of the *core function model*. It covers the strategy, evaluation, programming, execution, and improvements. This AM process in combination of an asset data system which is used as input of the process, the Asset management methodology is summarized sufficiently.

Municipalities looking at the model should comprehend that there are various *asset management maturity levels* the organization could fit in. The only way to improve their current maintenance process, so reaching effectiveness, is through Asset management (§ 10.2.1). It means that they need to increase their AM maturity level. In the transition model (Figure 10-1), the required process of change is supported with *change success factors*. This component shows that these success factors should always be adopted during a transition process.

In the black bar centered in the transition model, represent the most important element. The hindering factors of change listed in Chapter 9 , can be traced back to three fundamental factors; Leadership, Vision, and Communication.

According to Lafraia (2012, p. 10) the leadership has a dual role to reach "*permanent changes, in a sustainable way*". These same components were quoted by Interviewee St.1-114. However, based on an internal comparison between Interviewee 1 and interviewee 1 St.1, it was determined that the organization was not fully aligned on the subject of maintenance (§8.5). It was argued that it lacked vision, and communication with the disciplines. A leader should reinforce the organizational culture, and the operational discipline based on a vision through communication.

Another important element is the asset data system (Interviewee V.3, Interviewee V.4, interviewee V.6). According to them AM revolves around the data system as it is crucial as input for the process, and the output is updated in the system. However, a critical mind is reserved to

firstly include the critical assets, and thereafter extend with information and additional assets that are deemed to be noteworthy in the asset system.

In order to facilitate the municipalities in their transition towards Asset management, the core function model, transition factors, and success factors are translated into an *Asset management transition roadmap*. Following this roadmap leads to the *Objectives* mentioned in the model, and thereby to Asset management.

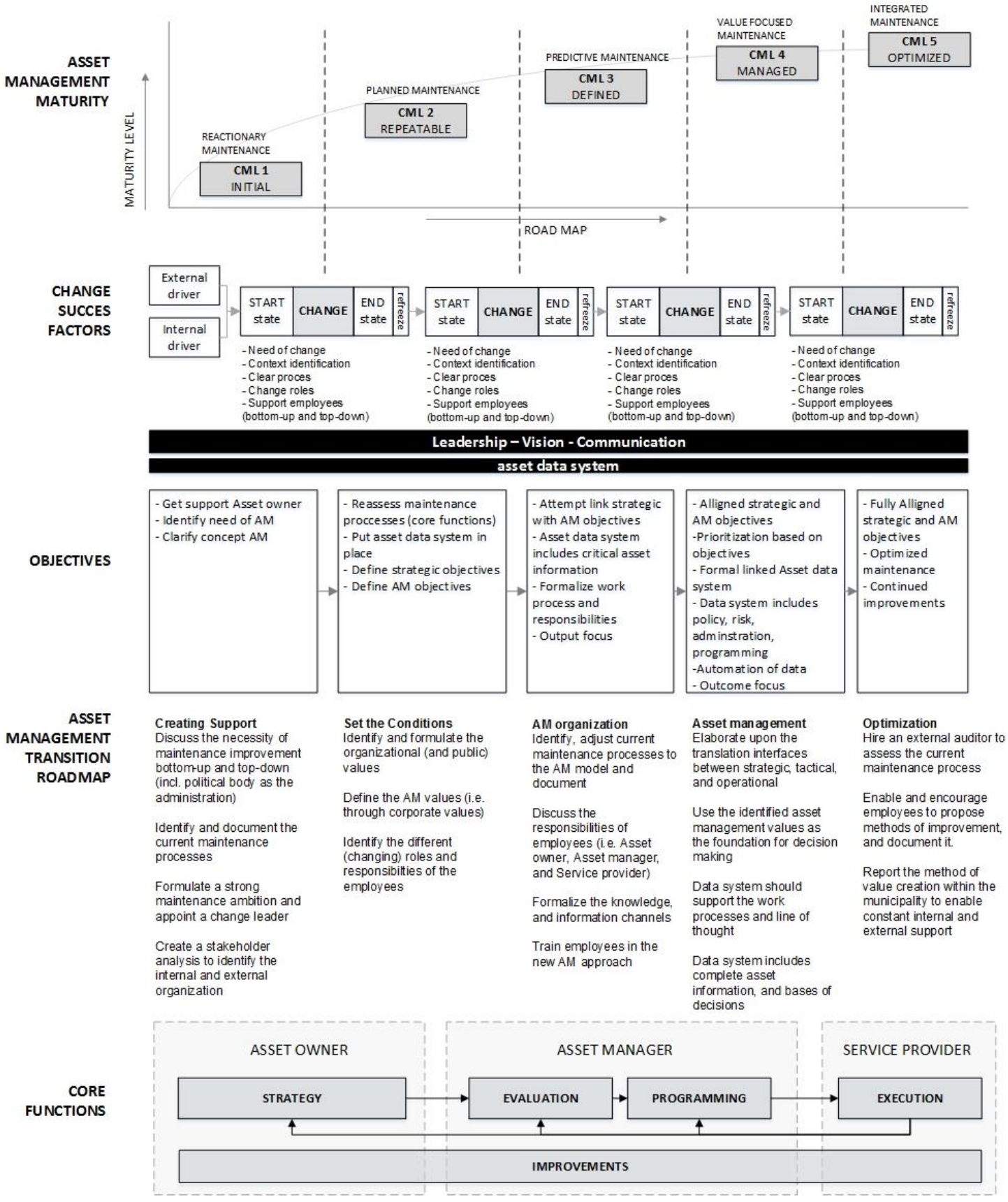



**Figure 10-1 Asset management Transition model**

# Chapter 11 **Validation**

*Before the conclusions are formulated, the results from Chapter 7 to Chapter 10 are validated with selected interviewees. Following the research model in Figure 2-1*, *the validation results are used to adjust and refine chapters 7 to 10. In this chapter the validation methodology is explained, and the findings leading to the adjustments are clarified.*

## 11.1 Introduction

In order to ensure the integrity of the results, used methods, and adopted procedures, a validation process is followed. Validation in the context of a research, is in accordance to Le Comple and Goetz (as cited in Brink (1993, p. 35)) "*the accuracy and truthfulness of scientific findings*". The validity is described as the practice that what is measured in the research conforms with what it is supposed to measure. In a *quantitative* research the validation methodology follows a logical and rational approach. For example, in a quantitative research interview (structured interview), whereas the interview protocol is standardized with fixed response options, the validation is assured by conducting a statistical analysis to determine the accuracy of the results. However, in a *qualitative* research, validation has a more subjective nuance as the '*accuracy*' and '*truthfulness*' of the findings are a lot harder to substantiate.

According to Denzin and Lincoln (1994, p. 785) a weakness of qualitative research is that the *external validity*, the extent to which the results is applicable across groups, is harder to proof. There is no quantification of numerical data that is used to draw the conclusions, instead, a phenomenon is described through description. Within a qualitative study, the researcher is at risk to unintentionally affect the research. Brink (1993, p. 35) states that as the researcher is the "*data-gathering instrument*" he influences the "*trustworthiness of data considerably*".

Yin (2003, p. 33), a renowned researcher on case study research and qualitative research, summarized four tests that's establishes the validity of a qualitative research;

- **Construct validity:** determination of the correct operational measures for the studied concepts
- **Internal validity:** determining the credibility of the results
- **External validity:** determination of the domain for which the results are applicable
- **Reliability:** demonstration that the study can be repeated, leading to identical results

Based on these concepts the validity of the thesis research is assessed.

## 11.2 Construct validity

In a research that revolves around interviews and case study research, the construct validity can be achieved through "*a literature review, use of multiple sources of evidence, establishing a chain of evidence, and having key external informants review the study report"* (Christie, Rowe, Perry, & Chamard, 2000, p. 310).

In the initial phase of the research a literature review was performed to determine the general problem areas within Asset management in municipalities (§ 2.1). There was a broad conception that municipalities are lacking a strong Asset management foundation. Furthermore in § 3.3 it was mentioned that practitioners employ different definitions for Asset management leading to unambiguity's in its process. A theoretical framework was developed based on the works of a number of authors, including (Huerne & Willems, 2011), that described how Asset management should be employed in practice. What followed was an interview protocol that was developed to

rank the municipalities on the Asset management aspects that are considered to be crucial AM factors (Appendix B, section III).

Secondly, another theoretical framework was developed on the subject of change (Chapter 5 ). It was determined how Asset management should be implemented from a theoretical perspective. This was also included in the interview protocol.

The chain of evidence was established through the literature studies, the subsequent interview protocols, the selection of the interviewees, a structured transcription of the data, and eventually a structured approach to the analysis of the interviews in Chapter 7 and Chapter 8 .

## 11.3 Internal validity

The credibility of the results were established through pattern matching, cross case analysis, and expert peer reviews. How Yin (2003) describes meeting the internal validity is through linking the analysis with the initial identified and established theoretical framework. This is met through the chain of evidence.

As the research method involves an interview approach, the internal validity is determined using the framework of Emans (2002, p. 72), the author of the book "*Interviewen: Theorie, techniek en training*". He mentioned that in the translation process between the answers of the interviewee and the interpretation of the researcher, most 'research' errors are made. Therefore he suggested four criteria to ensure the legitimacy of interview results (Emans, 2002, p. 86):

- **Validity**: Ensuring the alignment between an answer and the underlying cognition. Motives for the latter are for example, trying be friendly, social desirable responses, forgetfulness in past events, and suppression of controversial matters.
- **Completeness**: Important criteria is that the asked question is answered completely. Motives for falling short on this aspect are social desirable responses, forgetfulness, and different views on used terminology.
- **Relevance**: The answer should be relevant for the question asked. The interviewee could give an answer not matching the asked question by the researcher. This could be due to an attempt to avoid answering the question, or the asked question is unambiguous.
- **Clarity**: This criteria regards whether the researcher knows how to note, or approach the answer. Is the answer clear enough for the analysis used?

### *11.3.1 Expert peer review sample and validation round*

The validation participants were selected based on their position on the matrix tables in Chapter 7 and on their willingness to participate in an additional 'interview' (Appendix I). The municipal outliers interviewee 1 and interviewee 6 were incorporated in the validation. The main objective of the round was to validate the alignment of the answers of the interviewees in Appendix C and the method of analysis in Chapter 7 , and to validate the transition model.

Four validation interviews were conducted. The participants are listed in Appendix I, section I. The validation round consisted of three major section. The first section regards the AM core function model from § 3.6. Literature study had revealed that practitioners often have a different interpretation of Asset management. Moreover, the AM definition was vague and poorly understood. By validating the core function model with the interviewees, it was determined that the model consists of the most important concepts and processes of Asset management. Explaining AM through this model resulted in a mutual agreement upon its definition.

Secondly, the alignment of the answers given by interviewees in the first interview rounds (Appendix C), and the underlying condition (characteristics) of the matrix tables was validated. This output is summarized in Appendix I, section II. The validation characteristics table shows whether the participants agree with their position on the table. Through this step, internal validity was reached.

Thirdly, the 'results' (transition model) of the research was validated with the interviewees. Based on a theoretical funded research, whereas the real world (empirical research) is compared with the literature study, a transition model was formed. The rationale herein is that a change towards Asset management is a time consuming process that could take years. Therefore a multiyear transition with clear objectives is preferred. In the model, 5 categories are combined, (1) maturity model, (2) change success factors, (3) change objectives, a (4) practical Asset management transition roadmap, and (5) the core functions. The selected interviewees are asked whether the model is useable for consultation, and to identify, based on an assumed position in the model, whether the stated points in each stage are the then current priority factors. Nevertheless, the emphasis was on the usability of the model.

### *11.3.2 Validating pattern matching*

In the validation round, the core function model is presented to the interviewees. As mentioned earlier in this chapter's introduction, practitioners regard the asset management definition as an "*umbrella terminology*" (Interviewee St.3-135). In order to achieve a uniform definition, the core function model is shown to determine whether the model corresponds with their own interpretation on Asset management. The four interviewees agreed with the way AM is reflected in the model. The following statements are based on Appendix I, section III.

Interviewee V.1, acknowledges that the current organization is insufficient aware of the implications of AM. There is an understanding that the most important aspect is the linkage between policy and the operational activities. However, the interviewee outlines that his department is still seen as a separate entity within the organization. The reason given is that in contrast to the public space, his department and the derivative decision making is of a more complex nature, namely the tunnels. With this observation the interviewee basically denotes that the organization does not meet the core property of AM; the line between policy and operations.

Interviewee V.2, had no specific remarks on the model, besides a general tone that the current organization does not worry about the Asset management definition, or what the AM process exactly represents. Instead they focus on the first step whereas the asset data needs to be structured.

Interviewee V.4, maintains his own interpretation on AM, which means assets needs to be maintained in an efficient way in order to guarantee an optimal condition. In order to do so, the interviewee requires a long term vision, and information on the state of his assets.

Interviewee V.6, also mentions strategy as the most important property of Asset management. However, according to the interviewee the physical assets are missing. However, according to the researchers interpretation these asset fall under the core function 'managing assets', whereas they can be seen as input as the output of the process.

In short, regardless the fact that was determined that AM was poorly understood under practitioners. This short validation round in combination with the core function model reveals that at the highest abstraction level, we all agree upon its terminology. Asset management has two major components; the assets, and the line from strategy to operations (line-of-sight).

### *11.3.3 Validating cross case analysis*

The results of the unstructured interview given in Figure 7-1 visualizes how well the municipalities, from the perspective of the employee, employs AM tasks, and whether their objectives are aligned. In order to validate the alignment between the answers given by the interviewees (Appendix B, section I), and the position of the interviewees on the characteristics scale in § 7.4.1, the interviewees are given the option to respond on their corresponding classification, and their position compared to the other interviewees.

The table in Appendix I, section II, gives a summarized result of the validation round. Only on two occasions, the interviewee disagreed with the characteristics. Both disagreements were for question 2 that states how the maintenance is executed looking at the objectives, performance, and resources. Interviewee V.1 states that their maintenance is not based on performance evaluation of the asset, but instead their maintenance is preventive in nature. They ensure, through cyclical maintenance, their assets are functioning on an optimal level. Thereby, they disregard, the necessity of maintenance, and the organizational objectives. As a consequence their position on the characteristics scale has been reduced with a level, since it showcases an inefficient maintenance strategy (§ 7.4.1 is adjusted). In the AM mindset, value is only created within the discipline, and not organizational wide.

Interviewee V.4 states that their maintenance is not merely reactionary, but also includes preventive activities. The interviewee's interpretation on AM, is effective handling of people and assets. He argues that from a practical perspective the organization complies with AM, however decisions can't be made explicit. On the data information, he acknowledges that it is not readily available, but most information can be found in the outdated data system. Putting more weight on whether the maintenance is executed reactionary or mostly preventive, the interviewee is scaled a level higher in characteristics 2 (§ 7.4.1 is adjusted).

Based on the agreement on the allocation of the interviewees on the characteristics scale, with exception of the 2 allocation changes, we can conclude that the position of the other interviewees in § 7.4.1 can be accepted. Moreover, this means that the overall position in Figure 7-1 is a validated representation of the municipalities in the Netherlands. Based on this table we can assume that there is an emergent shift, conscious or not, towards Asset management. Most municipalities are well advanced in the rationale of Asset management, but most (7 out of 12) refuse to refer to it as a distinct methodology called Asset management. However, like interviewee V.4, they argue that their decision making process follows AM. However, they can't explicitly clarify why a maintenance activity is performed, and how assets are explicitly affected by it. This is a crucial component within Asset management, because it is a *structured* approach.

### *11.3.4 Validating cross case analysis (strategic level)*

As a mean to further substantiate the line-of-sight within the municipality, additional interviews at a strategic level was required. In § 8.5 the interview results were worked out. However, it is also intriguing, in the thesis context, to compare the interviews from municipal employees from the same organization. Basically, it is a simple comparison of sections between Appendix C, section I, and Appendix C, section II.

Table 11-1 shows which interviewees belong to the same organization, i.e. *interviewee 1* (Appendix C, section I) works for the same municipality as *interviewee St.1* (Appendix C, section II).

| Interviewee (unstructured) | Role | Interviewee (semi-structured) | Role |
|---|---|---|---|
| Interviewee 1 | O | Interviewee St.1 | S |
| Interviewee 3 | O | Interviewee St.3 | S |
| Interviewee 7 | T | Interviewee St.2 | S |

**Table 11-1 Interview participants from the same Municipality**

### Interviewee 1 and Interviewee St.1

The matrix tables in Chapter 7 shows that interviewee 1 scored lower than average on the line-of-sight characteristics. A major influential factor herein is the allocation of the interviewee on question 1 (Table 7-4). This question revolved around the alignment of the AM philosophy in the organization; recognition of the strategic objectives. Interviewee 1-6B stated that he was not required to substantiate what and why he does something, as he was mainly concerned in keeping the asset available. Moreover, in Table 7-7 another low score was given as there were no attempts made to integrate the asset data of interviewee 1, in an integrated asset model. The fragmentation of data is preserved. On the contrary, interviewee St.1-104 mentioned that the employee operating on that level should be able to substantiate how his activities contribute towards the objectives. It seems that on the operational level the departments predominantly work separately following their own work processes and experiences they have accumulated throughout the years. Using a statement made by Interviewee St.1, the story is inadequately carried over. It is an example of being unable to organize the work process in line with the maintenance vision.

### Interviewee 3 and Interviewee St.3

In Chapter 7 interviewee 3 scores average. The interviewee scored well on the characteristics in Table 7-6, whereas it was acknowledged that the organization had formulated strategic objectives, and AM objectives which were acknowledged throughout the organization. However, there was still a lack of alignment with the organizational goals. Interviewee St.3-131 stated that the organization assumes a practical approach in the maintenance process. Their ultimate goal is to comply with economic rational maintenance (Interviewee St.3-131). This is reached by focusing on adopting practical approaches that are proved to have a clear added value for citizens. For such the organization is currently concerned with managing their current assets in a data system (interviewee St.3-135, interviewee 3.B-33). The strategic line-of-sight is recognized in the municipality. However, they find it important that their own organizational culture is preserved. Maintenance optimizations are therefore not in line with a certain methodology, but proofed concepts are introduced in small increments. There is definitely a common view on maintenance in the organization.

### Interviewee 7 and Interviewee St.2

This municipality is one of the few who explicitly mentioned Asset management as the core maintenance process within its organization. In Chapter 7 no remarkable observations can be made for interviewee 7. However, comparing interviewee 7 and interviewee St.2, it is seen that both possess adequate knowledge on both the AM theory, as its applicability within their maintenance processes. They acknowledge the benefits the AM methodology has brought them, of which the most important that is aids the decision making process, and facilitates the discussions with the decision makers. Interviewee 7 operates on the tactical level, and interviewee St.2 on the strategic. Despite the fact that both recognize potential future improvements in the maintenance process, their views upon it are aligned.

## 11.4 External validity

Authors such as Yin (2003) and Christie et al. (2000, p. 18) mentioned that external validity can be reached with multiple case studies to develop '*analytical generalizations'* through '*replication logic*'.

As determined in Chapter 6 a municipality differs from other organizations in structure, but also in culture. From this perspective it is hard to determine whether the findings are transferable to a greater scope and therefore are fundamentally universal. The results from Chapter 10 showed that the emphasis of transition towards Asset management greatly leans on the employees within the organization. However, due to the organizational structure of municipalities (division political body and administration), the emphasis on public value, different priorities, the responsibilities of the municipality beyond infrastructural assets, and the internal culture, Asset management implementation is vastly complex. It is difficult to move the whole organization in the same direction if maintenance is concerned. Asset management is an organization wide approach and suffers when its implementation is fragmentized.

## 11.5 Reliability

The question asked in this section is whether another researcher would reach the same conclusions if he had followed the same research methodology. By incorporating the data used in this report and by referring to the used data in a structured way, a documentation trail is left behind.

The reliability of the results were also validated in a validation round, based on the theoretical framework, the key hindering factors for transition, and their AM maturity position. This is a vital section within the validation round, as it is validated whether the research objective "*How to contribute towards an improved strategic steering of maintenance within the Dutch municipalities by identifying components aiding the change process towards Asset management*" can be answered. Could the model improve the change process towards AM?

Interviewee V.1, agrees with the key factor hindering the transition process for municipalities towards AM. He acknowledges the existence of the fundamental causes behind those factors; leadership, vision, and communication. Referring back to § 11.3.4, where interviewee 1 and St.1 were compared, we argued that there was a deficit in *story telling* as the maintenance process at the strategic level differs from that on the operational level. This means that there is a defect in the factor communication, and perhaps the vision and leadership as well. Interviewee V.1 mentioned that his department can be seen as a separate maintenance organization whereas they assume the role of the asset owner, manager, and service provider. In practice this might lead to a workable maintenance process, but it encourages disintegration.

Interviewee V.3 states that his organization prefers a practical approach to AM, where they first focus on the data system. This system is regarded as the integrated link between discipline specialists. In the transition model this is incorporated as the integration of systems, which *"they are currently looking for*" (Interviewee V.3). When they Asset management methodology is clear for all employees in the organization, than the rest will follow. He emphasized the importance of a correct asset data system, and not the AM process itself as it will follow the data and the efforts of the employees. This perspective on the transition model is also shared by Interviewee V.4, and interviewee V.6.

Interviewee V.4 added that the responsible person on the tactical level should not directly interfere with the disciplines themselves, but should focus on the integration aspect instead. This stresses that the municipalities should be free to structure their organization to own perspective, but regardless should recognize the distinct responsibilities. This vision is in line with § 6.3,

where dividing the organization based on the three hierarchical levels, could also have negative impact.

## 11.6 Validation outcome

Using the four validity tests by Yin, it is determined that some vital validity elements are incorporated in the research. These elements ensure the validity of the report.

As validity also concerns a iterative process, changes were made based on the outcome of the validation round (Appendix I). The biggest changes were:

- Validation interviews are used to reassess the conclusions drawn in Chapter 9 .
- The core functions in the transition model (Figure 10-1) has been reduced to a few core theme's (strategy, evaluation, programming, execution, and improvements) to show that AM should not focus on the technical side, the processes, but rather on the rationale
- The allocation of the interviewees in the matrix tables in § 7.4.1, has been shifted and corrected based on the validation round.
- The transition model has been modified, to emphasize the data system, and leadership, vision, and communication. Thereafter a practical Asset management transition roadmap was added.

# Chapter 12 **Conclusion and recommendations**

*In this section of the report the conclusions and recommendations are given.*

## 12.1 Thesis summary

In § 2.3 the research objective was formulated that consisted of the following elements: (1) current state of maintenance in the Dutch municipalities, and (2) how could they further improve the AM implementation. The last statement is based on § 7.4.2, whereas the interviewees were asked to describe their method to improve their maintenance process, it was observed that municipalities were aiming for identical goals; correct information, ability to talk with the political body, increased effectiveness and efficiency of their maintenance process, and the ability to make more considerate decisions. The latter is dependent on an assessment to maximize the value within the municipality. In other words, "*…its relationship to the active goal*" (Markman & Brendl, 2000, p. 98) (also see Appendix J, section II). In conclusion it can be noted that municipalities strive for improved maintenance, and the goals they strive for are covered by the Asset management methodology.

The state of maintenance (based on the strategic linkage) within municipalities was determined based on a comprehensive interview under 11 different municipalities, and 1 additional province. If we first look at the organizational structure, municipalities have a natural advantage in comparison to private parties, as from a hierarchical perspective there is a division visible in strategic, tactical, and operational level (Figure 6-1). However, interviewee 6-60 mentioned that the Council is not inclined to see themselves as the Asset owner. This might be one of the causes of the lack of linkage between the strategic level and the tactical level within municipalities. As a result, (multiple) role responsibilities are spread out among various employees.

In Figure 7-1, the state of maintenance of a municipality is determined based on the interview results. It should be understood as the overall Asset management level, with regards to the line-of-sight, within municipalities in the Netherlands. The argument can be reached that there are positive trends noticeable towards full line-of-sight AM. The basic is present, but multiple iterations are required to refine, redefine, and improve the fundamentals of their Asset management processes and system. Based on this table we can assume that there is an emergent shift, conscious or not, towards Asset management. Most municipalities are well advanced in the rationale of Asset management, but most (7 out of 12) refuse to refer to it as a distinct methodology different from the current (interviewee V.4). Nevertheless they can't explicitly elaborate why a maintenance activity is performed, and how assets are directly affected by it. This is a crucial component within Asset management, because it is a *structured* approach. In conclusion, improvements are predominantly required in the tension field between strategic and tactical level whereas they have to rethink how value can be made measurable.

Based on preliminary research on Asset management, the line-of-sight model of Huerne and Willems (2011) was adopted as it gave a comprehensible view on the strategic link between policy and operational activities. It was used as a directive in the creation of the core function model (Figure 3-4). The model consists of the most crucial process functions of Asset management, but recognizes that the integration of these function is the most important (line-of-sight).

To aid the change process towards AM, the change management literature was reviewed. Based on the change management theories of Lewin, Lippitt, and Pettigrew (§ 5.3), the success factors of change were determined. These were (Chapter 9 ):

I. Identification of External and Internal drivers
II. Clarifying the need of change
III. Vision
IV. Understanding the context
V. Clear process
VI. Change roles
VII. Communication
VIII. Leadership
IX. Refreeze
X. Core functions

It is a business reality that an organization is undergoing constant change (Buckley, 2013). This change process is stimulated due to the constant search towards competitive advantage by organizations. However, this need is translated to municipalities in the form of compulsory efficiency and effectiveness, as public resources are used. Based on the empirical research it was determined that the factors hindering the municipalities in the transition process towards Asset management were (Chapter 9 ):

I. Demands of the Asset owner
II. Integration of
III. Related change processes
IV. Resistance of
V. Unambiguous objectives
VI. Reliable data
VII. Unknown concept

These hindering factors are traced back to three fundamental change factors mentioned earlier: Leadership, Vision, and Communication.

Another emphasis within the Asset management process is put on the asset data system (§11.5). According to the interviewees a change process towards AM should start with ordering the assets. The data is used as input for the process, and the output is consequently incorporated in the data system. Without a sound data system, and without reliable information, it is impossible to balance costs, risks, and performance, impossible to allocate financial resources, and impossible to make a correct decision. These are elements, that were designated as the purpose of Asset management in § 3.4.

Using the research, and results of the report a transition model was created in Chapter 10 . This model summarizes the findings of this research, and concludes that a municipality is able to improve the strategic steering of maintenance (through AM), by following the roadmap, while taking into account the vital factors of change.

## 12.2 Thesis conclusion

How the municipalities could further improve the AM implementation is covered by the research question.

> *How to contribute towards an improved strategic steering of maintenance within the Dutch municipalities by identifying key components aiding the change process towards Asset management?*

The answer on this question is elaborated upon in Chapter 9 and Chapter 10 where the key factors and transition model is described. The model was developed based on the theoretical understanding of Asset management, change management, and the empirical study under 11 municipalities. Moreover, the model was validated by the interviewees. Finally there are some key focal points that resulted from this study.

Municipalities should cease their resistance against adopting the Asset management approach in their maintenance process. People employed in the municipalities often keep firmly on traditional ways, and heuristics. A common statement made by those is that they already perform Asset management (Interviewee 8-74.A). However, this is only partially true. They pinpoint and select certain aspects of the Asset management process (certain core functions see § 3.5), and believe they have reached an efficient and effective way to conduct their maintenance. Instead, the opposite is true, by only selecting certain elements of the AM process their actual maintenance vision has not changed. This is an organizational challenge, and therefore requires a change leader who is able to convey the message, and is able to gain support within the organization leading to a core team initiating the change,

People often neglect that AM revolves around creating value. The only way to determine whether value is created is through an *explicit* linkage between strategic goals, and maintenance activities. How an activity contributes towards a goal, is the question municipalities should be asking themselves in the future. Current developments to reach this goal is promising (corporate values matrix, Appendix G), but regardless it is not yet an optimal solution as it is not measurable. It is concluded throughout this report that additional research is required on whether a full functional decomposition of assets can be used to make this problem more measureable. However, I agree with interviewee St.3-133 who stated that we need to "*avoid doing theoretical analyses that sound logical, but does not directly lead to more value for the citizens*". From a practical perspective, a slimmed-down form of AM is wished for, but in practice this will only lead to a state where the decision making is not substantiated towards the created values determined by the political body. One of the reasons why this not yet seen as a problem is because the political body (seen in the report as Asset owner), does not formulate the right question. They ask '*What is the overdue maintenance, and what is needed to overcome these'*. Instead they should be asking, '*Show me evidence that the maintenance objectives are met (Note Capital goods) in an efficient and effective manner while taking the Vision documents into account'.*

## 12.3 Recommendations

The following recommendations are made based on the completed research.

1. The first step, even before a lot of thought is put on the AM process, is to organize and structure the asset data system. This component is the most vital element within the process, as each decision relies on the correctness and availability of the data. In addition, thought should be put on how this data is used (how it is analysed). When this process is uniformly agreed upon, and it is clarified which data and which asset is vital, and how data is used, only then the maintenance process can be developed further. Hire employees with an affinity for bringing structure in data or outsource it.
2. Municipalities value the short lines between departments, and also between the political body, management, and government administration. They interpret a formalized

hierarchical structure (asset owner, asset manager, and service provider), as an assault on their own organizational values, and culture. They argue that this creates distance, and perverts the cooperation between departments as it creates a ranking between employees. It is been said that is not needed to formalize it as role descriptions, but the distinct responsibilities of each role should be acknowledged. Municipalities need to comprehend that it is not advised to group all hierarchical responsibilities within one executing department, using the argument that they are the specialists and know what they are doing. This causes disintegration, and a lack of alignment across the technical disciplines.

3. The state of Asset management within municipalities is more forward-looking than anticipated in the initial phase (Figure 7-1). However, the problems they encounter is that the maintenance vision (story) is not communicated well to the operational levels. From the employee's perspective Asset management comes across as *another* empty methodology that will fade in a few years. Despite, they express a strong ambition to improve their maintenance in order to more efficient and effective. However, without a sound AM process, and a rigorous asset data system, it is impossible to demonstrate both effectiveness as efficiency. It emphasises the need of a skilful change leader who is able to convey the Asset management story, and persuade employees to enter the change process with them. Brecken (2004) mentioned in an article on strategic leadership, the importance of a vision to inspire and motivate the employees. However, interviews on the work floor showed that leaders within municipalities are often seen as outsiders. The practitioners argue that they have abundant experience and knowledge on their respective discipline, that they believe they are the most qualified to make decisions both on a strategic, tactical, as operational level. Therefore, my opinion is that the leader should originate from the own organization, and moreover should approach their change process bottom-up.
4. Due to the shift of responsibilities in the governmental structures, municipalities are increasingly aware that they need to collaborate with others, being other municipalities or market parties. Most are engaged herein, and have established collective circles to learn from each other. However, there exist the danger that adopting new approaches from other municipalities will lead to reduced or even opposite results. This is traced to the different context of each organization. Municipalities are encouraged to share practical ideas, but need to carry out independent analyses to determine the risk, and the impact on their organization. To distribute the risks of innovation, pilot projects are recommended wherein different aspects belonging to AM (decision making process, certain data system, functional breakdown structure) are tested in practice. Combining these results in a collective circle with other municipalities will lead to the selection of the best option. The municipalities need to be aware that it is not a competition between each other, but rather they are now all dependant on each other.
5. From the research on Asset management implementation within municipalities the core rationale was that yes the technical side of AM is important, but at this stage (referring to Chapter 7 ), the emphasis should be put on the social side of Asset management and the further transition to improved maintenance. Municipalities need to objectively, and critically assess their current maintenance process and ask themselves; '*Are you really satisfied with how the maintenance is organized in the municipality'.* To reach the necessary momentum of change, the Asset owner (political body) needs to change their focus towards the long term strategy, instead of only looking at the quick results to satisfy their electors. The governmental administration plays an important role in correcting that.
6. Change in the maintenance process in municipalities is a current matter. Consultants, who are seen as outsiders, could profit from this development by focusing on small developments within the Asset management process. As mentioned earlier, the leadership and vision needs to be set and developed by the own internal organization. The role a consultancy could play herein is supportive, but should be limited in order to avoid resistance among the employees. A better area of focus is the technical side of

Asset management (core functions see Figure 3-3). How can a municipality structure a strategic plan, how can they perform risk management, which tools can be used? By providing these guides they will display their added value for a municipality, as each technical process should also fit the context of the organization.

The following recommendations are made directed towards municipalities divided in size, and hierarchical level of the employee.

| | **Municipality size** | | |
|---|---|---|---|
| **Hierarchical level** | *Small (S)* | *Medium (M)* | *Large (G)* |
| *Operational* | -Monitor assets and keep the asset system up to date<br>-Accept the new role of the service provider and do not hold on to the old values | -Monitor assets and keep the asset system up to date<br>-Accept the new role of the service provider and do not hold on to the old values | -Monitor assets and keep the asset system up to date<br>-Accept the new role of the service provider and do not hold on to the old values |
| *Tactical* | -Outsource supporting and secondary activities<br>-Build on existing best practices<br>-Adopt strategic objectives as the starting point for the activities<br>-Focus on correct and up to date asset data<br>-Preserve the small lines between departments<br>-Empower change bottom-up<br>-Follow the footsteps of large municipalities who have shown success | -Determine whether activities are outsourced or kept internal<br>-Adopt strategic objectives as the starting point for the activities<br>-Focus on correct and up to date asset data<br>-Start change top down and followed by a bottom-up approach<br>-Follow the footsteps of large municipalities who have shown success | -Determine whether activities are outsourced or kept internal<br>-Extent the knowledge. Be innovative and build best practices (I.e. functional approach)<br>-Adopt strategic objectives as the starting point for the activities<br>-Focus on correct and up to date asset data<br>-Compete with market parties to attract employees or outsource the operational tasks<br>-Start change top down and followed by a bottom-up approach |
| *Strategic* | -Emphasize the need for an integrated strategic infrastructure planning and maintenance<br>-Set out clear conditions for the Asset manager<br>-Hold the Asset manager accountable based on compliancy with the strategic objectives<br>-Empower the leadership of the own employees<br>-Search for forms of intense collaboration between other municipalities (discipline wide) | -Emphasize the need for an integrated strategic infrastructure planning and maintenance<br>-Set out clear conditions for the Asset manager<br>-Hold the Asset manager accountable based on compliancy with the strategic objectives<br>-Empower the leadership of the own employees<br>-Search for knowledge collaboration | -Emphasize the need for an integrated strategic infrastructure planning and maintenance<br>-Set out clear conditions for the Asset manager<br>-Hold the Asset manager accountable based on compliancy with the strategic objectives<br>-Empower the leadership of the own employees<br>-Search for knowledge collaboration |

**Table 12-1 Recommendation matrix, municipality size versus hierarchical level**

# Chapter 13 **Reflection**

*In this section, the thesis approach, and process is evaluated. The approach is assessed with in mind the scientific foundation, and whether the results are valid, and more importantly useful. In addition a personal view upon the process is given.*

## 13.1 Reflecting on the thesis approach

A basic prerequisite of a thesis at an academic level is using the scientific method in conducting the study. According to Glazunov (2012, p. 9) this entails a collection of techniques that "*investigates a phenomena, acquires new knowledge, or corrects and integrates previous knowledge*", based on "*observable, empirical, and measureable evidence*".

The first step in the research is to formulate the core problem. Employing an initial literature study on Asset management, based on personal interactions with subject experts, and following the rationale of researchers of academic papers it was determined that overdue maintenance stimulated the search for efficient and effective maintenance approaches within municipalities. However, a strong Asset management foundation was lacking within these organizations. The last sentence has given me direction in this thesis to figure out why AM was not widely accepted yet, and what is needed.

The objective was therefore set to tackle the problem by identifying how the municipalities currently approach their maintenance processes, and what steps are required to further improve the maintenance process. This objective was set out as the area of focus throughout the whole thesis process. Dividing the research into two broad sections; theoretical framework, and empirical study, the approach is evaluated.

The theoretical framework consists of an asset management framework to determine *what* AM is (Chapter 3 ), followed by an analysis on how AM impacts an organization (Chapter 4 ), and finally a chapter on change theory to facilitate the AM transition process (Chapter 5 ).

In Chapter 3 the embraced methodology, to define asset management visually, identified the most important functions of the AM process. It resulted in a core function model (Figure 3-2). The way the core function were chosen are clarified, and elaborated upon. However, from a scientific standpoint it is debatable whether the top core functions meets the criteria being observable and measureable. In Appendix D, the whole core function table is included containing 40 different core functions. Based on a form of text mining the most common mentioned functions, in literature, were recognized as core functions. This approach is susceptible to the subjectivity of the researcher. Nevertheless, the model has aided both the researcher, and the interviewee participants to define the Asset management process in a simple visual appealing manner.

In Chapter 4 the organizational impact of Asset management is evaluated, based on how the identified core functions from Chapter 3 affect the organization economically, externally, and socially. This method of research originates from the impact evaluation approach (i.e. CSIRO (2015)). However, as seen in Appendix F, the evaluation is performed at a high abstraction level. Regardless, in retrospect its usage mainly lied in the fact that it was identified that the Asset management process largely impacted the interrelationship between the organizational employees, rather than drastically changing the current technical maintenance process. Based on this observation, Chapter 5 was created whereas the change theory was introduced.

In Chapter 5 different change theory were assessed to determine the most crucial transition factors in a change process. These factors aid municipalities to take into account the pitfalls when an Asset management methodology or other approach is introduced in the organization.

In the empirical research 13 participants were interviewed based on three themes: hierarchical levels within the organization, line-of-sight, and change. As the themes revolve around strategic objectives, my supervisors suspected that there was a shortage of participants operating on a strategic level within the municipalities. As a result, 3 additional interviews were conducted.

The interviews were all recorded and transcribed in order to preserve valuable information, and to facilitate the analysis process by the researcher (Appendix C). It was helpful that the first 13 interviews followed an unstructured protocol, as two main objectives was reached. First, the interviews were used to determine the actual practical problem. In the beginning it is hard to come up with a sound problem statement which will form the foundation of the thesis. Therefore preliminary conversations with municipalities was crucial to clarify this step. Secondly, by using an unstructured approach I was able to evolve the interview protocol during the interview process with the 13 interviewees. Also, by giving them room in the conversations (going off script), more information was acquired, and additional questions were formulated that were not considered earlier.

The transition model was created based on the results of the thesis. However due to the direction of the research, which led to a more social character of Asset management, the model became more abstract. It might look like an under substantiated model, but in my opinion it does represent the core line of this research; the difficulties in the change towards Asset management is not the process itself, but the organizational culture and the ‘story’.

## 13.2 Thesis limitations

There are a number of limitations within the thesis outside the time, and budget constraints. The maintenance within municipalities were assessed with the goal to determine the state of maintenance of municipalities in the Netherlands. However, this was predominantly carried out by interviewing one municipal employee per municipality. There were documents used to substantiate their comments, but they were not the leading method to assess the process. As a consequence an interview performed with an employee on an operational level could lead to a different AM interpretation as one on a tactical. This was observed by comparing interviewee 1 and interviewee St.1 (§11.3.4).Therefore the results of Chapter 7 can only be interpreted as the results of that particular employee instead of the whole municipality. Question could be asked whether instead of conducting interviews among different municipalities, a case study was performed with only one, could lead to a better recommendations and insight in the state of Asset management within municipalities.

Another limitation is that it was problematic to analyze the interview results due to the unstructured nature of it. To coop with this problem a quote-research was followed to list statements made by the interviewees, and group them under the specific interview question (category). I acknowledge that this approach leaves a lot of room for subjectivity. However, the results were also validated with a number of participants to limit the bias.

Also the thesis contains various theories and subjects ranging from Asset management, Systems engineering to Change management. Due to the number of those it was impossible to elaborate those subjects even more. A consequence is that the thesis is more general than detailed, affecting the quality of the conclusions and recommendations.

## 13.3 Reflecting on the thesis process

My personal reflection on the thesis process is bleak. The process has cost me many months, far exceeding the 6 months it was projected to take. Moreover, I found it very hard to formulate a problem which is supported both academically as practically. I have to acknowledge that it was a period of trial and error, but it has taught me a lot, both on the subject matter as personally.

It was also hard to gather willing interview participants, and schedule the meetings in an efficient manner. Most of the time there is a long timeframe between two meetings. You really need to manage your process, and set out milestones or else it is impossible to stay within the projected time of the thesis process. It requires internal discipline. This is the most important factor to successfully write a thesis. A factor I struggled with.

Before I started my thesis a friend of mine told me "*it was the darkest period of my life*". Now I understand, and it says enough.

## 13.4 Future research

The subject on Asset management has been researched thoroughly, and many theses are written on the subject matter. Regardless, there are still many research possibilities to write about within the AM methodology.

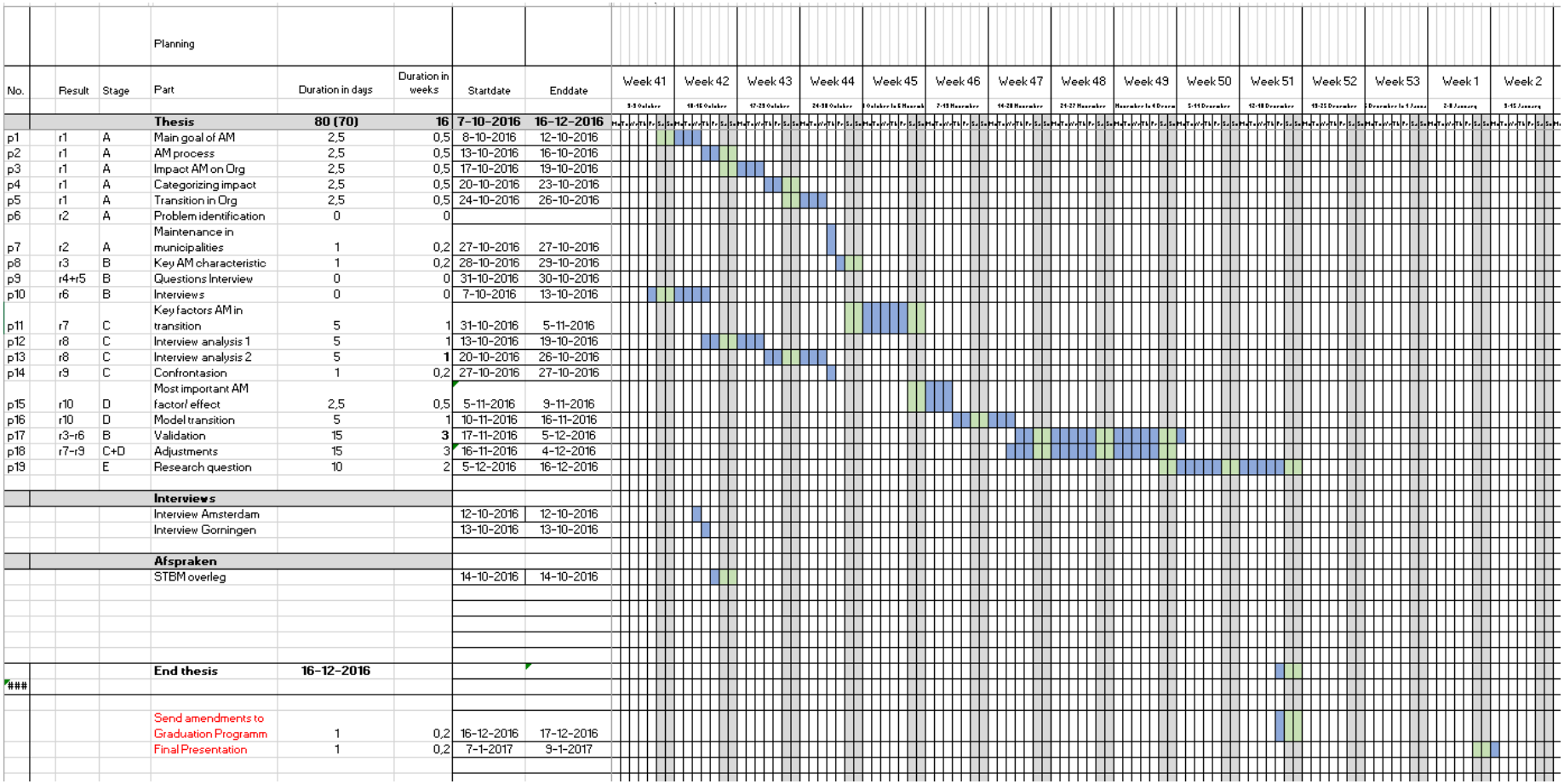
**Analyzing the effect of functionalities as a bridge between objectives and maintenance activities, on the maintenance decisions**

Huerne and Willems (2011) have created an AM model, whereas functionalities are used to translate the objectives into function fulfillers (system objects) (§ 1.3). This rationale is in line with the Systems engineering mindset elaborated in § 6.5. However, based on empirical research under the municipalities this mindset, as a distinct approach, was not deemed important for the current maintenance process (Chapter 7 , Chapter 8 ). The interviewees mentioned that the practical benefits of such approach is not yet understood. Therefore further research is required to determine the actual practical implications of functionalities on the maintenance decision making process. Which benefits are gained from it, and will it really lead to drastically other maintenance activities.

**Alignment Asset management rationale and actual compliance with Asset management within municipalities (in accordance to the NEN-ISO 55000)**

In Chapter 7 , and Chapter 8 the state of Asset management within municipalities (rationale on the line-of-sight) was assessed. It showed that the municipal employees had a good understanding of AM, and in addition have structured a lot of processes in line with the methodology. There are still slight improvements to be made to make decisions more explicit, and traceable in a data system. However, it is valuable to assess whether the mindset of the municipalities are in line with the technical assessment on compliance with AM in accordance to the NEN-ISO 55000. In short, the question is what is needed for a municipality to be an Asset management certified organization?

# Appendix A Project Schedule



| No. | | Result | Stage | Part | Duration in days | Duration in weeks | Startdate | Enddate |
|---|---|---|---|---|---|---|---|---|
| | | | | Planning | | | | |
| | | | | **Thesis** | **80 (70)** | **16** | **7-10-2016** | **16-12-2016** |
| p1 | | r1 | A | Main goal of AM | 2,5 | 0,5 | 8-10-2016 | 12-10-2016 |
| p2 | | r1 | A | AM process | 2,5 | 0,5 | 13-10-2016 | 16-10-2016 |
| p3 | | r1 | A | Impact AM on Org | 2,5 | 0,5 | 17-10-2016 | 19-10-2016 |
| p4 | | r1 | A | Categorizing impact | 2,5 | 0,5 | 20-10-2016 | 23-10-2016 |
| p5 | | r1 | A | Transition in Org | 2,5 | 0,5 | 24-10-2016 | 26-10-2016 |
| p6 | | r2 | A | Problem identification | 0 | 0 | | |
| p7 | | r2 | A | Maintenance in municipalities | 1 | 0,2 | 27-10-2016 | 27-10-2016 |
| p8 | | r3 | B | Key AM characteristic | 1 | 0,2 | 28-10-2016 | 29-10-2016 |
| p9 | | r4+r5 | B | Questions Interview | 0 | 0 | 31-10-2016 | 30-10-2016 |
| p10 | | r6 | B | Interviews | 0 | 0 | 7-10-2016 | 13-10-2016 |
| p11 | | r7 | C | Key factors AM in transition | 5 | 1 | 31-10-2016 | 5-11-2016 |
| p12 | | r8 | C | Interview analysis 1 | 5 | 1 | 13-10-2016 | 19-10-2016 |
| p13 | | r8 | C | Interview analysis 2 | 5 | **1** | 20-10-2016 | 26-10-2016 |
| p14 | | r9 | C | Confrontasion | 1 | 0,2 | 27-10-2016 | 27-10-2016 |
| p15 | | r10 | D | Most important AM factor/ effect | 2,5 | 0,5 | 5-11-2016 | 9-11-2016 |
| p16 | | r10 | D | Model transition | 5 | 1 | 10-11-2016 | 16-11-2016 |
| p17 | | r3-r6 | B | Validation | 15 | **3** | 17-11-2016 | 5-12-2016 |
| p18 | | r7-r9 | C+D | Adjustments | 15 | 3 | 16-11-2016 | 4-12-2016 |
| p19 | | | E | Research question | 10 | 2 | 5-12-2016 | 16-12-2016 |
| | | | | **Interviews** | | | | |
| | | | | Interview Amsterdam | | | 12-10-2016 | 12-10-2016 |
| | | | | Interview Gorningen | | | 13-10-2016 | 13-10-2016 |
| | | | | **Afspraken** | | | | |
| | | | | STBM overleg | | | 14-10-2016 | 14-10-2016 |
| ### | | | | **End thesis** | **16-12-2016** | | | |
| | | | | Send amendments to Graduation Programm | 1 | 0,2 | 16-12-2016 | 17-12-2016 |
| | | | | Final Presentation | 1 | 0,2 | 7-1-2017 | 9-1-2017 |

# Appendix B Interview protocol

## Appendix B, Section I - Interviewees

| | Municipality | Size | Interviewee | E-mail | Function | Role | Date |
|---|---|---|---|---|---|---|---|
| 1 | Den Haag | G | [*Confidential*] | [*Confidential*] | -Technisch medewerker<br>-Projectleider Dienst Stadsbeheer | O | 18-07-2016 |
| 2 | Rotterdam | G | [*Confidential*] | [*Confidential*] | Asset Manager Wegen& Openbare Verlichting | T | 9-08-2016 |
| 3.A | Utrecht | G | [*Confidential*] | [*Confidential*] | Teamleider Civiele Constructies | O | 10-08-2016 |
| 3.B | Utrecht | G | [*Confidential*] | [*Confidential*] | Hoofd Advies en Informatie | T | 22-09-2016 |
| 4 | Dordrecht | M | [*Confidential*] | [*Confidential*] | Teamleider Constructies& Havens | O | 1-09-2016 |
| 5 | Haarlem | M | [*Confidential*] | [*Confidential*] | Implementatie Adviseur | T | 19-09-2016 |
| 6 | Noord-Holland/ Zuid-Holland | | [*Confidential*] | [*Confidential*] | Professional Asset Management Adviseur | T | 12-09-2016 |
| 7 | Amsterdam | G | [*Confidential*] | [*Confidential*] | Asset Manager Civiele Constructies | T | 12-10-2016 |
| 8 | Eindhoven | M | [*Confidential*] | [*Confidential*] | Afdelingshoofd Stadsbeheer | S | 5-10-2016 |
| 9 | Barneveld | K | [*Confidential*] | [*Confidential*] | Beheerder Openbare Ruimte | O | 15-09-2016 |
| 10 | Leusden | K | [*Confidential*] | [*Confidential*] | Adviseur Civiel, Infrastructuur en Verkeer | O | 16-09-2016 |
| 11 | Groningen | M | [*Confidential*] | [*Confidential*] | Coördinator Beheer | T | 13-10-2016 |
| 12 | Ede | M | [*Confidential*] | [*Confidential*] | Afdelingsmanager Programmering Leefomgeving & Veiligheid | S | 3-10-2016 |

# Appendix B, Section II – Additional Interviewees Strategic level

| | **Municipality** | **Size** | **Interviewee** | **E-mail** | **Function** | **Role** | **Date** |
|---|---|---|---|---|---|---|---|
| S1 | Den Haag | G | [*Confidential*] | [*Confidential*] | Algemeen directeur Stadsbeheer | S | 10-02-2017 |
| S2 | Amsterdam | G | [*Confidential*] | [*Confidential*] | Hoofd Beheer Openbare Ruimte | S | 20-02-2017 |
| S3 | Utrecht | G | [*Confidential*] | [*Confidential*] | Groepshoofd Civiele Techniek | S | 03-03-2017 |

# Appendix B, Section III – Unstructured interview protocol

| | |
|---|---|
| **Line-of-Sight** | |
| 1 | Hoe heeft de gemeente de beheer organisatie binnen de gemeente georganiseerd? |
| 2 | Op welke wijze wordt het onderhoud binnen de gemeente uitgevoerd, kijkend naar de doelen, prestaties en middelen? |
| 3 | Welke gemeentelijke beleidsdoelen zijn er opgesteld met betrekking tot het beheer en hoe worden deze geborgd? |
| 4 | In hoeverre zijn jullie met de huidige middelen in staat om inzichtelijk te maken wat voor impact een onderhoudsactiviteit heeft op de werking van het totale asset netwerk? |
| 5 | Wordt er tijdens het maken van beheerafwegingen nog gekeken naar de functionaliteit van een asset, en wordt dit ad hoc gedaan of bestaat er een expliciete relatie met de asset (verwijzend naar de functionele structuur)? |
| | |
| **Asset management implementation** | |
| 6 | Indien de gemeente al bezig is met Asset management implementatie, wat was het omslagpunt hiervoor?<br>Of<br>Welke stappen zullen in de nabije toekomst gezet worden om het beheer binnen de gemeente te verbeteren, AM? |
| 7 | Welke problemen of knelpunten voorzie jij nog in de toekomst die de verder implementatie kan beïnvloeden. |
| 8 | Kijkend naar het transitie proces of naar de wijze waarop de gemeente het onderhoud heeft ingevuld, wat zijn de sterke punten die de gemeente hanteert? |
| | |

Interview protocol (Ongestructureerd) gemeentes – Nederlands

# Appendix B, Section IV – Semi-structured interview protocol

## Semigestructureerd Interview gemeentes

*Introductie*
Mijn afstudeeronderzoek gaat over de wijze waarop gemeenten hun beheer hebben ingericht, en of de onderhoudsactiviteiten zijn te herleiden tot de strategische doelstellingen van de gemeente. De kerntaak van gemeenten is om waarde te creëren voor inwoners, het is daarom belangrijk om inzichtelijk te maken hoe het geld wordt besteed en waarom. Vanuit een stuk empirisch onderzoek en een theoretisch onderzoek is vastgesteld dat voornamelijk de stap tussen de strategische doelstellingen en tactische doelstellingen moeilijk expliciet is te maken. Met behulp van dit interview wil ik voornamelijk hierop focussen en helder krijgen op welke wijze dat op dit moment binnen de gemeente gebeurd, welke eisen er gesteld zijn door de strategische asset owner waaraan het ambtelijk apparaat moet voldoen, en welke stappen er volgens u nodig zijn om het onderhoud binnen de gemeente te verbeteren.

*Organisatie (2 min)*
1. De gemeente bevat meerdere afdelingen en heeft een eigen hiërarchische indeling kenmerkend voor gemeenten. Kunt u beschrijven wie binnen de gemeente de rol van Asset owner heeft en hoe hij met die rol omgaat?

*Strategisch naar tactisch (15 min)*
3. Om waarde te creëren is het belangrijk dat de gehele organisatie werkt naar een gezamenlijk doel. Hebben alle werknemers opererend op strategisch, tactisch en ook operationeel niveau inzicht in hoeverre hun werkzaamheden invloed hebben op de doelstellingen vastgesteld door de Asset owner? En komt dit tot uiting in hun beslissingen?

4. Kunt u beschrijven welke randvoorwaarden u mee heeft gekregen van de Asset owner, en op welke wijze deze richting geven aan uw werkzaamheden?

5. Dient u kenbaar te maken aan de Asset owner dat u voldaan heeft aan de gestelde randvoorwaarden? En is de wijze waarop dit gedaan wordt expliciet genoeg voor hen?

6. Bent u van mening dat de gemeente het onderhoud strategisch stuurt?

7. Bent u van mening dat er überhaupt een verschil is tussen een strategische sturing en een tactische?

8. Op welke wijze dragen de infrastructurele assets bij aan de waarde creatie binnen de gemeente?

9. Worden er nu onderhoudsactiviteiten uitgevoerd die niet bijdragen aan creatie van waarde voor de gemeente?

*Change (10 min)*
10. Bent u van mening dat de lopende onderhoudsprocessen binnen de gemeente verbeterd dienen te worden?

11. Wat is uw visie op het beheer binnen de gemeente, waar wilt u uiteindelijk naar toe?

12. Is Asset management een methodiek die verder uitgewerkt gaat worden binnen de gemeente?

13. Wat zijn volgens u de meest belangrijkste factoren die nodig zijn ter ondersteuning van het proces om het beheer te verbeteren?

# Appendix C Interviews

## Appendix C, Section I – Unstructured interviews

The interviews of each municipality is transcribed in Dutch.

## Interview: Den Haag (*Interviewee 1)*

**Transcript Den Haag**

Datum: 18 juli 2016
Adres: Spui 70, Den Haag
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

## Interview: Rotterdam (*Interviewee 2)*

**Transcript Rotterdam**

Datum: 9 Augustus 2016
Adres: Wilhelminakade 179, Rotterdam
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

## Interview: Utrecht (*Interviewee 3.A)*

**Transcript Utrecht**

Datum: 10 augustus 2016
Adres: Koploperstraat 50-52, Utrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

## Interview: Utrecht (*Interviewee 3.B)*

**Transcript Utrecht**

Datum: 22 september 2016
Adres: Koploperstraat 50-52, Utrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

## Interview: Dordrecht (*Interviewee 4)*

**Transcript Dordrecht**

Datum: 1 september 2016
Adres: Maasstraat 17, Dordrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

## Interview: Haarlem (*Interviewee 5)*

**Transcript Utrecht**

Datum: 19 september 2016
Adres: Zijlvest 39, Haarlem
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

## Interview: Noord-Holland (*Interviewee 6)*

**Transcript Noord-Holland**

Datum: 12 september 2016
Adres: Delft
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: /

[*Confidential*]

## Interview: Amsterdam (*Interviewee 7)*

**Transcript Amsterdam**

Datum: 12 Oktober 2016
Adres: Weesperplein 8, Amsterdam
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

## Interview: Eindhoven (*Interviewee 8)*

**Transcript Eindhoven**

Datum: 5 oktober 2016
Adres: Stadhuisplein 10, Eindhoven
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

## Interview: Barneveld (*Interviewee 9)*

**Transcript Barneveld**

Datum: 15 september 2016
Adres: Kallenbroekerweg 121, Barneveld
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Klein (minder dan 100.000 inwoners)

[*Confidential*]

## Interview: Leusden (*Interviewee 10)*

**Transcript Leusden**

Datum: 16 september 2016
Adres: Fokkerstraat 16, Leusden
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Klein (minder dan 100.000 inwoners)

[*Confidential*]

# Interview: Groningen (*Interviewee 11)*

**Transcript Noord-Holland**

Datum: 13 september 2016
Adres: Duinkerkenstraat 45, Groningen
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

# Interview: Ede (*Interviewee 12)*

**Transcript Ede**

Datum: 3 oktober 2016
Adres: Bergstraat 4, Ede
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

## Appendix C, Section II – Structured interviews

The interviews of each municipality is transcribed in Dutch.

# Interview: Den Haag (*Interviewee St.1)*

**Transcript Den Haag**

Datum: 10 februari 2017
Adres: Spui 70, Den Haag
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

# Interview: Amsterdam (*Interviewee St.2)*

**Transcript Amsterdam**

Datum: 20 februari 2017
Adres: Weesperplein 8, Amsterdam
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

# Interview: Utrecht (*Interviewee St.3)*

**Transcript utrecht**

Datum: 3 maart 2017
Adres: Koploperstraat 50-52, Utrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

# Appendix D Asset Management core functions identification

| | | DOCUMENTATION ON ASSET MANAGEMENT FUNCTIONS IN REVERSED CHRONOLOGICAL ORDER | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Functions (no particular order) | Wijnia, Y., de Croon, J. (2015) | United Energy (2015) | Hastings, N.A.J. (2014) | NEN-ISO 55000 (2014) | TheIAM (2014) | AAMCoG (2012) | Brown, R.E. (2010) | Frolov, V. et al. (2010) | | SUM | |
| 1 | Corporate strategy | x | x | x | x | x | x | x | x | | 8 | >0,7 |
| 2 | Capital planning (CAPEX) | x | x | x | x | x | x | x | x | | 8 | >0,7 |
| 3 | Maintenance planning/ policy | x | x | x | x | x | x | x | x | | 8 | >0,7 |
| 4 | Performance evaluation | x | x | x | x | x | | x | x | | 7 | >0,7 |
| 5 | Managing through audit/ | x | x | x | x | x | x | x | x | | 8 | >0,7 |
| 6 | Operations planning | x | x | | x | x | x | x | x | | 7 | >0,7 |
| 7 | Strategic planning | x | x | x | x | x | x | x | | | 7 | >0,7 |
| 8 | Data management | x | x | x | x | x | x | | | | 6 | >0,7 |
| 9 | Risk management | x | | x | x | x | x | x | | | 6 | >0,7 |
| 10 | System- and software engineering | x | x | x | x | x | x | | | | 6 | >0,7 |
| 11 | Configuration management | x | x | x | x | x | x | | | | 6 | >0,7 |
| 12 | Capability management/ | x | x | x | x | x | x | | | | 6 | >0,7 |
| 13 | Business values | x | x | | x | x | x | x | | | 6 | >0,7 |
| 14 | Budgeting (OPEX) | x | | x | x | x | x | x | | | 6 | >0,7 |
| 15 | Condition monitoring | | x | x | x | | | x | | | 4 | |
| 16 | Environmental management | | x | x | x | x | x | | | | 5 | |
| 17 | Life Cycle Costing | | | x | x | x | x | x | | | 5 | |
| 18 | Financial management | x | | x | x | | | x | | | 4 | |
| 19 | Procurement | x | | x | | x | x | x | | | 5 | |
| 20 | Execution | x | x | x | | | | x | | | 4 | |
| 21 | Standards development | | x | | | x | | x | x | | 4 | |
| 22 | Business security (availability, reliability, maintainability...) | | | x | x | x | | | | | 3 | |
| 23 | Financial targets | x | | | x | | | x | | | 3 | |
| 24 | Identifying AM knowledge | | | x | x | | | | x | | 3 | |
| 25 | Project evaluation | | | x | | | | x | x | | 3 | |
| 26 | Outage response | | | x | | x | | x | | | 3 | |
| 27 | Asset management leadership | | x | | x | x | | | | | 3 | |
| 28 | Change management | x | | x | | x | | | | | 3 | |
| 29 | Stakeholder engagement | | x | x | | x | | | | | 3 | |
| 30 | Inspection | | | | x | | | x | | | 2 | |
| 31 | Project management | | | x | x | | | | | | 2 | |
| 32 | Facilitair management | | | x | x | | | | | | 2 | |
| 33 | Power management | | x | | x | | | | | | 2 | |
| 34 | Outage strategy | | | x | | x | | | | | 2 | |
| 35 | Systems Engineering | | | x | | x | | | | | 2 | |
| 36 | Asset decommissioning | | | x | | x | x | | | | 3 | |
| 37 | Quality management | | | | x | | | | | | 1 | |
| 38 | Non-destructive research | | | | x | | | | | | 1 | |
| 39 | Demand analysis | | | | | x | | | | | 1 | |
| 40 | Market opportunities | | | x | | | | | | | 1 | |

| Nr. | Functions | Alternate descriptions |
|---|---|---|
| 1 | Corporate strategy | Strategy (Management process)<br>Corporate plan<br>Organizational strategic management |
| 2 | Capital planning (CAPEX) | Corporate finance<br>Capital budgets<br>Capital investment decision-making |
| 3 | Maintenance planning | Programming<br>Program register<br>Maintenance decision-making |
| 4 | Performance evaluation | Performance reporting<br>Asset performance<br>Performance & health monitoring |
| 5 | Managing through audit/ improvements | Management review<br>Business and technical review<br>Effectiveness review<br>Assurance<br>Evaluation |
| 6 | Operations planning | Asset management planning<br>Operational works program<br>Operations decision-making |
| 7 | Strategic planning | Strategic asset management planning |
| 8 | Data management | Information management<br>Information systems and data |
| 9 | Risk management | Risk identification<br>Risk structuring<br>Risk evaluation<br>Opportunity management |
| 10 | System- and software engineering | System management<br>Systems structure |
| 11 | Configuration management | |
| 12 | Capability management | Human resources (competence)<br>Organization<br>Manage capability<br>AM competence<br>Organizational structure<br>Competence management |
| 13 | Business values | Organizational values<br>Corporate values |
| 14 | Budgeting (OPEX) | Cost balancing<br>Capital program (operation)<br>Operating budgets |
| 15 | Condition monitoring | Monitoring system<br>Condition assessment |
| 16 | Environmental management | Environment<br>Sustainable development<br>Sustainability |
| 17 | Life Cycle Costing | Asset valuation<br>Lifecycle value realization<br>Asset costing<br>Whole of life AM |
| 18 | Financial management | |
| 19 | Procurement | Contracting |

| | | |
|---|---|---|
| | | Supply chain management<br>Acquisition |
| 20 | Execution | Asset creation<br>Service delivery |
| 21 | Standards development | Standards and procedures<br>Standards and legislation<br>Regulatory management |
| 22 | Business security (availability, reliability, maintainability...) | |
| 23 | Financial targets | |
| 24 | Identifying AM knowledge | |
| 25 | Project evaluation | Options selection |
| 26 | Outage response | Reporting system<br>Fault & incident |
| 27 | Asset management leadership | Leadership governance |
| 28 | Change management | Managing change |
| 29 | Stakeholder engagement | Customer connections<br>Community demands |
| 30 | Inspection | |
| 31 | Project management | |
| 32 | Facilitair management | |
| 33 | Power management | Power quality |
| 34 | Outage strategy | Response strategy<br>Shutdown strategy |
| 35 | Systems Engineering | Requirements engineering |
| 36 | Asset decommissioning | Disposal |
| 37 | Quality management | |
| 38 | Non-destructive research | |
| 39 | Demand analysis | Business significance |
| 40 | Market opportunities | Market offer |

# Appendix E Asset Management definitions

| Literature | Definitions |
|---|---|
| International Standards Organisation (2014a) (NEN-ISO 55000) | "*Coordinated activity of an organization to realize value from assets"* in which the assets are defined as an "*item, thing or entity that has potential or actual value to an organization"* |
| Hastings (2014, p. 10) | "*...the set of activities associated with identifying what assets are needed, identifying funding requirements, acquiring assets, providing logistic and maintenance support for assets, disposing and renewing assets, so as to effectively and efficiently meet the desired objective*" |
| Federal Highway Administration (2015) | "*...a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle*" |
| van der Velde, Hooimeijer, and Meima (2010, p. 10) | "*… anno 2010 wil zeggen dat je precies weet*<br>- *Wat je in huis hebt aan objecten*<br>- *Hoe dit zich vertaalt naar de prestaties van je objecten*<br>- *Welke risico's er nu en in de toekomst om de hoek komen kijken*<br>- *Welke kosten aan dit alles verbonden zijn*" |
| AAMCoG (2012) | "*…is the process of organising, planning, designing and controlling the acquisition, care, refurbishment, and disposal of infrastructure and engineering assets to support the delivery of services. It is a systematic, structured process covering the whole life of physical assets*" |
| Haider (2007) | "*…entails preserving the value function of an asset during its lifecycle and maintaining it to as designed or near original condition through maintenance, upgrade, and renewal until sustainable retirement of the asset due to end of need or technology refresh*" |
| Woodhouse (2003) | "*The set of disciplines, methods, procedures & tools to optimise the Whole Life Business Impact of costs, performance and risk exposures (associated with the availability, efficiency, quality, longevity and regulatory/ safety/environmental compliance) of the company's physical assets."* |

# Appendix F Literature study impact Asset management

| STRATEGIC LEVEL | | | | |
|---|---|---|---|---|
| **Research paper** | **Core function** | **Impact** | **Impact category** | **Clarification** |
| Johnson, Scholes, and Whittington (2008) | Corporate Strategy | -Clarify value determination<br>-Improve allocation of resources<br>-Recognize influence stakeholder expectations<br>-Understand capability (resources and competence)<br>-Scoping diversification portfolio of products<br>-Structure organization for success<br>-Improve business focus | Economic impact - Intangible<br>External impact – Intangible | Every organization has a corporate strategy. However, recognizing the importance of a strategic vision for asset is important. |
| Bowman and Helfat (2001) | Corporate strategy | -Increase competitive advantage<br>-Improve profitability | Economic impact - Intangible | |
| Wijetunge and Pushpakumari (2014) | Strategic planning | -Clear vision<br>-Able to identify and prioritize strategic objectives<br>-Set boundaries risks<br>-Balancing innovation and proven methods<br>-Enable flexibility<br>-Develop policies towards vision<br>-Able to delegate responsibilities<br>-Balance needs and expectations stakeholders | Economic impact – Intangible<br>External impact – Intangible<br>Social impact - Human | Strategic planning allows a firm to manage and deliver a service as efficient ass possible. It includes both tangible, as intangible resources, but also focusses on the responsibilities of employees. It includes measurable objectives within a certain timeframe. |
| Steiner (2010) | Strategic planning | -Evaluation alternative course of action<br>-Identify opportunities, threats, strength, weakness<br>-Allocation resources<br>-Adjust based on performance monitoring<br>-Permits top management to look at the enterprise as a whole | Economic impact – Intangible<br>Economic impact - Tangible<br>External impact - Intangible | |

| TACTICAL LEVEL | | | | |
|---|---|---|---|---|
| **Research paper** | **Core function** | **Impact** | **Impact category** | **Clarification** |
| Gitau (2015) | Risk management | -Minimize negative impact on performance (time, cost, quality, safety, sustainability)<br>-Manage changing project condition<br>-Manage quality contract documents<br>-Identify opportunities to mitigate risks<br>-Assessment reliability resources (data) | Economic impact – Tangible<br>Economic impact - Intangible<br>External impact - Intangible | At the heart of AM stands a risk based approach. Identifying risks and managing and mitigating them when necessary increases asset performances. Moreover, it is vital information for the decision making process. |
| Tekavčič, Šević, and Sprčić (2008) | Risk management | -Used as a lever for value creation<br>-Decrease costs of financial distress<br>-Reduce agency costs<br>-Improve sufficient internal funds for planned investments<br>-Increase expected utility<br>-Improve communication towards market<br>-Used as a tool to signal management quality | Economic impact – Tangible<br>Economic impact - Intangible<br>External impact - Intangible | |
| Dart (1990) | Configuration management | -Reduce problems and inefficiencies<br>-Ensure integrity product<br>-Audit trail of asset and artifacts<br>-Represents architecture of product<br>-Able to gather statistics on the asset<br>-Controlling how and when changes are made<br>-Enable team to develop and maintain assets | Economic impact – Tangible<br>Economic impact - Intangible<br>External impact – Tangible<br>Social impact – Human | Configuration management ensures the traceability of data and assets. It thereby increases the efficiency of employees, retrieving data when needed, and the operational value of the system. |
| Lapouchnian, Yu, and Mylopoulos (2007) | Configuration management | -Selecting alternatives driven by data and events<br>-Maintain traceability of processes<br>-Usable as a tool to predict | Economic impact – Tangible<br>Economic impact - Intangible | |
| Maug and Naik (1995) | Performance evaluation | -Decision making based on superior information rather than emotional<br>-Acquiring perfect information is seen more valuable than risky higher expected returns | Economic impact - Intangible<br>External impact – Tangible | With performance evaluation the company is able to |
| Micheli and Manzoni (2010) | Performance evaluation | -Align behaviors and attitudes<br>-Optimize implementation and review of organizational strategy<br>-Improve communication results (towards stakeholders)<br>-Strengthening corporate brand and reputation | Economic impact - Intangible<br>External impact – Intangible<br>Social impact – Human | |

| | | | | |
|---|---|---|---|---|
| | | -Motivating employees at all levels<br>-Promoting a performance improvement culture<br>-Promoting a learning organization<br>-Gap evaluation | | |
| GAO (2007) | Capital planning | -Identification of capital assets<br>-Clarify how capital relates to achieving the goals and objectives (strategic linkage)<br>-Alternatives evaluation<br>-Balancing the existing assets and new investments | Economic impact – Tangible<br>Economic impact – Intangible | With a capital planning system in place the firm is able to look at the bigger picture, and prioritize projects based on opportunities and requirements. It results in significant cost savings, lower repair costs, and procurement costs. |
| Allen, Kelly, Rhodes-Whitley, and Donaldson (2014) | Capital planning | -Focus attention on organizational goals, needs and financial capabilities<br>-Improves community awareness<br>-Improve internal and external cooperation and communication<br>-Avoid wasted resources<br>-Ensuring financial stability | Economic impact – Tangible<br>Economic impact – Intangible<br>External impact – Intangible<br>Social impact - Human | |
| Transport for NSM (2015) | Maintenance planning | -Clarification operational roles<br>-Define and verify work process<br>-Determining service level<br>-Opportunity integration of various departments | Economic impact – Tangible<br>Economic impact – Intangible<br>Social impact - Human | In maintenance planning, the asset manager enhances the strategic link between the strategic objectives and the maintenance on assets. It is decided whether assets need maintenance, renewal, or disposal. |
| RIvers (2013) | Maintenance planning | -Strategically combine/schedule maintenance and planned repairs<br>-Avoiding low utilization<br>-Avoiding false sense of high availability<br>-Shifting percentage unplanned repairs to planned repairs | Economic impact – Tangible<br>Economic impact – Intangible<br>Social impact - Human | |
| Qi (2010) | Budgeting | -Formal budgeting promotes higher growth (improves asset handling)<br>-Clear capital budget goals improves budget performance<br>-More formal budgetary control leads to higher growth in profit (efficiency)<br>-Greater budgetary participation leads to better management performance<br>-Achieving better non-financial performance | Economic impact – Tangible<br>Economic impact – Intangible | In practice each organization has to deal with budgets. In governmental organization this is even more important as they also have to substantiate their expenditures. |

| | | | | |
|---|---|---|---|---|
| Gupta (2014) | Budgeting | -Limit perceived value of financial planning process<br>-Optimal level of detail for budgeting<br>-Enables best financial forecast<br>-Making bottle-necks in process transparent<br>-Usable by multiple parties to monitor progress<br>-Improve forecasting | Economic impact – Tangible<br>Economic impact – Intangible | |

| **OPERATIONAL LEVEL** | | | | |
|---|---|---|---|---|
| **Research paper** | **Core function** | **Impact** | **Impact category** | **Clarification** |
| Gaskill and Van Auken (1994) | Operational planning | -Assessing personnel capabilities and commission work<br>-Determining factors of discontent<br>-Analyzing training needs<br>-Reviewing and estimate equipment need<br>-Translation strategic plans into functional areas<br>-Clear short-term goals | Economic impact – Tangible<br>Economic impact – Intangible<br>Social - Human | The operational plan specifies what is done on an operational level to comply with the required asset performance, and the strategic objectives. |
| DFID (2010) | Operational planning | -Clarify role personnel<br>-Provide necessary detail of strategy implementation<br>-Provide confidence to deliver results<br>-Set out Why, What and How the results are delivered<br>-Enable improvement by evaluation<br>-Demonstrating value for money<br>-Clarify why/what you are communicating | Economic impact – Tangible<br>Economic impact – Intangible<br>Social - Human | |
| | Execution | / | | Execution regards performing the activities set out in the Operational plans. |
| | Execution | / | | |
| Rao (1996) | Condition monitoring | -Enables decision making based on substantive and corroborated diagnostic information<br>-Both proactive as predictive approach<br>-Measures lacking variables<br>-Measures system's input/output relationship | Economic impact – Tangible<br>Economic impact – Intangible | With condition monitoring an organization is able to keep up with current data on assets. This is vital in the decision making process. |

| | | | | |
|---|---|---|---|---|
| | | -Focusses on cost reduction in maintenance rather blanket coverage<br>-Driven by financial. Operational and safety requirements | | |
| May, McMillan, and Thöns (2015) | Condition monitoring | -Enables detection of failure before it occurs<br>-Increases Operations and Monitoring savings<br>-Increases lifetime assets | Economic impact – Intangible | |

| **INTEGRATION AND IMPLEMENTATION** | | | | |
|---|---|---|---|---|
| **Research paper** | **Core function** | **Impact** | **Impact category** | **Clarification** |
| Birkinshaw and Hagström (2000) | Capability management | -Identify capability gaps<br>-Improve organizations 'flexibility<br>-Enable the management of internal flow of information<br>-Tap into external sources of knowledge<br>-Identification best practices<br>-Improves resource allocation<br>-Enables a more effectively conceptualization of an organizations workings (understand where competitive advantage is created)<br>-Understanding how value is perceived from those capabilities | External impact - Intangible<br>Economic impact – Intangible<br>Social impact - Human | This regards the management of the organization on a more social level. It consists of identifying the gaps in the firm, and respond in on it. |
| Grant (1996) | Capability management | -Improve integration of knowledge<br>-Bridge gap strategic management and organization theory<br>-Device decision process that permits integration of specialized knowledge throughout whole organization<br>-Internal capability is a more stable basis for strategy than market positioning | External impact - Intangible<br>Economic impact – Intangible<br>Social impact - Human | |
| Goodhue, Wybo, and Kirsch (1992) | Data management | -Greater effectiveness organization<br>-Reduces costs<br>-Reduces redundant design efforts<br>-Increase ability to collect, share and aggregate information | Economic impact – Intangible<br>Social impact - Human | Data is considered to be an intangible resource. Without an effective data management system, an organization is |

| | | | | |
|---|---|---|---|---|
| | | -Improve communication and coordination<br>-Insight in impact through interaction of variables | | unable to coop with complex projects, systems, and assets. |
| Loshin (2012) | Data management | -Identifying opportunities<br>-Eludes impaired decision making<br>-Identifying what data is used as input and how output is employed<br>-Identifying data objects critical for successful operation<br>-Traceability decision making and documentation | Economic impact – Intangible<br>Social impact - Human | |
| Zokaei et al. (2010) | System- and software engineering | -Focus on delivering the central purpose of the service (effectiveness)<br>-Conscientious study of the actual demand<br>-Empowers the engagement of employees<br>-Recognize there is a system of interaction | Economic impact – Intangible<br>Social impact - Human | This core function indicates that systems thinking is required to understand the interrelationships between independent resources. Without such approach, the firm is unable to connect thoughts and actions effectively. |
| Morgan (2005) | System- and software engineering | -Recognize capabilities outside the formal structure of the organization (system of systems)<br>-Recognize interrelationship that shape their own role and work<br>-See the big picture (impact on others, and others on them)<br>-Understand system (past, present, and future)<br>-Identify key relationships<br>-Focus on system as a whole (from differentiation to collaboration)<br>-Understand workings of a system and align their actions | Economic impact – Intangible<br>Social impact - Human | |
| Fernholz and Fernholz (2007) | *Implementation* | -Improved services based on asset use<br>-Increase revenue<br>-Improve credit rating organization<br>-Attract investors<br>-Improve asset valuation<br>-Enhance environment, improve quality of life<br>-Provision useful information for decision making | Economic impact – Intangible<br>External impact - Intangible<br>Social - Human | Implementing each individual core function is not Asset management. They are just tools to support lining up the strategic objectives, and the activities. The underlying idea is the line-of-sight. |
| Schreuder (2015) | *Implementation* | -Connecting vision, policy, and plans<br>-Better control of workload<br>-Insight in risks | Economic impact – Intangible<br>External impact - Intangible<br>Social - Human | |

| | | | | |
|---|---|---|---|---|
| | | -Improved management confidence<br>-Improved reputation<br>-More challenging job<br>-More flexibility | | |

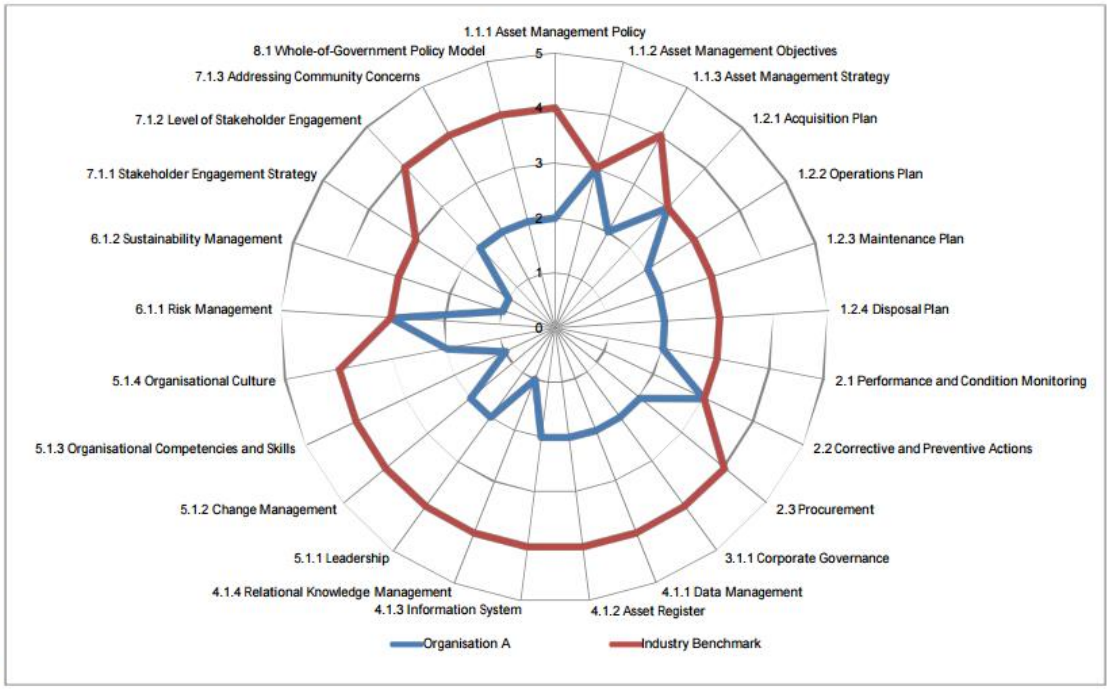
# Appendix G Corporate values matrix

| | Potentiele gevolgen op de bedrijfswaarden | | | | | | | | | | | Frequentie of kans van optreden | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beschikbaarheid | | | | | Veiligheid | Milieu / gezondheid | | Kwaliteit Leefomgeving | Imago | Wet & Regelgeving | Economie | Vrijwel onmogelijk <0,003/jr | Zelden 0,003 - 0,03 /jr | Incidenteel 0,03 - 0,3 /jr | Jaarlijks 0,3 - 3 /jr | Maandelijks 3 - 30 /jr | Wekelijks >30 /jr |
| Extreem | Hoofdwaterkering buiten gebruik in stormseizoen > 100 dagen | Netwerkschakel niet beschikbaar >5.000.000 gebruiksdagen | nvt | nvt | nvt | meerdere doden | Overstort droog weer situatie > 5.000 m3. | Overstort neerslag situatie > 365.000 m3. | Overlast van water op straat >2.500 gebruiksdagen | Opstappen wethouder | veroordeling | >€ 10.000.000,- | M | H | ZH | O | O | O |
| Ernstig | Secundaire waterkering /schutsluis buiten gebruik i n stormseizoen > 100 dagen | Netwerkschakel niet beschikbaar 500.000 tot 5.000.000 gebruiksdagen | nvt | nvt | nvt | een dode, blijvend ernstig letsel / invaliditeit | Overstort droog weer situatie 500 - 5.000 m3. | Overstort neerslag situatie 36.500 - 365.000 m3. | Overlast van water op straat 250 tot 2.500 gebruiksdagen | Wethouder berispt / meerdere raadsvragen in actualitietenraad | strafzaak | € 1.000.000,- tot € 10.000.000,- | L | M | H | ZH | O | O |
| Behoorlijk | Secund.waterkering buiten gebruik in stormseizoen 10 tot 100 dagen Stremming beroepsvaart >1000 gebruiksdagen | Netwerkschakel niet beschikbaar 50.000 tot 500.000 gebruiksdagen | nvt | Openbare groenvoorziening niet beschikbaar >100.000 gebruiksdagen | nvt | ernstig gewond | Overstort droog weer situatie 50 - 500 m3. | Overstort neerslag situatie 3.650 - 36.500m3. | Overlast van water op straat 25 tot 250 gebruiksdagen | Raadsvragen | dwangbevel | € 100.000,- tot € 1.000.000,- | V | L | M | H | ZH | O |
| Matig | Secund.waterkering buiten gebruik in stormseizoen 1 to 10 dagen Stremming beroepsvaart 100 tot 1000 gebruiksdagen | Netwerkschakel niet beschikbaar 5.000 to 50.000 gebruiksdagen | Openbare verlichting Niet beschikbaar zijn van > 1000 gebruiksdagen, aaneengesloten langs een weg of fietspad | Openbare groenvoorziening niet beschikbaar 10.000 tot 100.000 gebruiksdagen | Speelvoorziening niet beschikbaar >10.000 gebruiksdagen | gewond met verzuim | Overstort droog weer situatie 5 - 50 m3. | Overstort neerslag situatie 365 - 3.650 m3. | Overlast van water op straat 2,5 tot 25 gebruiksdagen | Veel negatieve publiciteit | schikking | € 10.000- tot € 100.000,- | V | V | L | M | H | ZH |
| Klein | Schutsluis beroepsvaart buiten gebruik 1 tot 10 dagen Stremming beroepsvaart 10 tot 100 gebruiksdagen | Netwerkschakel niet beschikbaar 500 tot 5000 gebruiksdagen | Openbare verlichting Niet beschikbaar zijn van 100 tot 1000 gebruiksdagen, aaneengesloten langs een weg of fietspad | Openbare groenvoorziening niet beschikbaar 1000 tot 10,000 gebruiksdagen | Speelvoorziening niet beschikbaar 1000 tot 10,000 gebruiksdagen | bijna ongeval | Overstort droog weer situatie 0,5 - 5 m3. | Overstort neerslag situatie 35 - 365 m3. | Overlast van water op straat 0,25 tot 2,5 gebruiksdagen | Negatieve publiciteit | boete | € 1.000,- tot € 10.000,- | V | V | V | L | M | H |
| Nihil | Schutsluis beroepsvaart buiten gebruik 1 dag Stremming beroepsvaart < 10 gebruiksdagen | Netwerkschakel niet beschikbaar < 500 gebruiksdagen | Openbare verlichting Niet beschikbaar zijn van 10 to 100 gebruiksdagen, aaneengesloten langs een weg of fietspad | Openbare groenvoorziening niet beschikbaar < 1000 gebruiksdagen | Speelvoorziening niet beschikbaar <1000 gebruiksdagen | gevaarlijke situatie | Overstort droog weer situatie < 0,5 m3. | Overstort neerslag situatie < 35 m3. | Overlast van water op straat < 0,25 gebruiksdagen | Geringe publiciteit | waarschuwing / schade | < € 1.000,- | V | V | V | V | L | M |

Bedrijfswaardenmodel Rotterdam

# Appendix H Asset management Capability maturity model

| Report (Individual Score) | Organisation A | Industry Benchmark |
|---|---|---|
| 1.1.1 Asset Management Policy | 2 | 4 |
| 1.1.2 Asset Management Objectives | 3 | 3 |
| 1.1.3 Asset Management Strategy | 2 | 4 |
| 1.2.1 Acquisition Plan | 3 | 3 |
| 1.2.2 Operations Plan | 2 | 3 |
| 1.2.3 Maintenance Plan | 2 | 3 |
| 1.2.4 Disposal Plan | 2 | 3 |
| 2.1 Performance and Condition Monitoring | 2 | 3 |
| 2.2 Corrective and Preventive Actions | 3 | 3 |
| 2.3 Procurement | 2 | 4 |
| 3.1.1 Corporate Governance | 2 | 4 |
| 4.1.1 Data Management | 2 | 4 |
| 4.1.2 Asset Register | 2 | 4 |
| 4.1.3 Information System | 2 | 4 |
| 4.1.4 Relational Knowledge Management | 1 | 4 |
| 5.1.1 Leadership | 2 | 4 |
| 5.1.2 Change Management | 2 | 4 |
| 5.1.3 Organisational Competencies and Skills | 1 | 4 |
| 5.1.4 Organisational Culture | 2 | 4 |
| 6.1.1 Risk Management | 3 | 3 |
| 6.1.2 Sustainability Management | 1 | 3 |
| 7.1.1 Stakeholder Engagement Stategy | 1 | 3 |
| 7.1.2 Level of Stakeholder Engagement | 2 | 4 |
| 7.1.3 Addressing Community Concerns | 2 | 4 |
| 8.1 Whole-of-Government Policy Model | 2 | 4 |




AMCAaMM.(K. Brown, Keast, and Mahmood, 2015, 11)

# Appendix I Validation strategy

## Appendix I, Section I – Interviewees

| | Municipality | Size | Interviewee | E-mail | Function | Role | Date |
|---|---|---|---|---|---|---|---|
| 1 | Den Haag | G | [*Confidential*] | [*Confidential*] | -Technisch medewerker<br>-Projectleider Dienst Stadsbeheer | O | 07-03-2017 |
| 3.B | Utrecht | G | [*Confidential*] | [*Confidential*] | Hoofd Advies en Informatie | T | 03-03-2017 |
| 4 | Dordrecht | M | [*Confidential*] | [*Confidential*] | Teamleider Constructies& Havens | O | 21-02-2017 |
| 6 | Noord-Holland/ Zuid-Holland | | [*Confidential*] | [*Confidential*] | Professional Asset Management Adviseur | T | 20-02-2017 |

# Appendix I, Section II – Validation characteristics table

| | Validation interview | | 1 | 3 | 4 | 6 |
|---|---|---|---|---|---|---|
| **1** | **How is the maintenance organization within the municipality organized?** | | | | | |
| | 1 | The leadership style of the organization is not aligned with the AM philosophy. Moreover, there is no SAMP, no adequate AMS, and the performance of the AMS is not reported to the top management. | V | | V | |
| | 2 | The leadership acknowledges the benefits, however no concrete plans are undertaken to align the whole organization. Moreover there is no SAMP, but there is an attempt made to improve the asset network with a quality level approach. An AMS is integrated subpar (required information when needed), and not always the correct information can be retrieved. | | | | |
| | 3 | The leadership is fully supportive for the AM implementation. Concrete plans are being executed to further this agenda. There is no SAMP, but attempts are made to prioritize AM measures for the asset network. An AMS is integrated subpar (required information when needed), but measures are taken to remove erroneous information. | | V | | |
| | 4 | The leadership is able to convey the need for AM, and the Asset owner is supportive. Start state of the organization is identified, as well as the end state. There is an attempt to create a SAMP. There is an AMS with critical information, however not yet all information can be retrieved and is reported. | | | | |
| | 5 | The leadership extends from the strategic towards the operational levels. There is a SAMP which includes how assets need to perform to comply with the objectives. An AMS is fully integrated and measures are taken to continually improve the system. | | | | V |
| **2** | **How is maintenance executed, referring to the objectives, performances, and resources?** | | | | | |
| | 1 | There are no formalities in place, and maintenance is reactionary. Decisions are not made based on the agency objectives. Moreover, each discipline has their own data system, leading to scattered information. | | | ~~X~~ | |
| | 2 | Maintenance is mostly reactionary, with preventive measures ad hoc. Data on compliance with the Performance measures is not readily available. Decisions are not made based on the agency objectives. | V | | V | |
| | 3 | Maintenance is mostly preventive, with reactionary measures ad hoc. Data is documented, and there are Performance measures identified. Decisions are based on an analysis of the performance results. | ~~X~~ | V | | |
| | 4 | Maintenance is determined based on performance objectives. Moreover, the measures are strategically prioritized. Data is documented and monitored. | | | | V |
| | 5 | Maintenance is aligned with the agent objectives. Decisions are made base on how it effects the objectives. Data is documented, evaluated, and forecasted. | | | | |
| **3** | **Which organizational objectives are defined with regards to the maintenance process, and how are they fulfilled/ substantiated?** | | | | | |
| | 1 | The organization has not formulated strategic objectives or they are not known. | | | | |
| | 2 | The organization has formulated strategic objectives. However these are not widely acknowledged or meaningful used. | V | | V | |
| | 3 | The organization has formulated strategic objectives and Asset management objectives, but the latter were formulated without considerations to the strategic objectives. | | | | |
| | 4 | The organization has formulated strategic objectives and Asset management objectives. There is still a lack of alignment with the organizational goals, but the AM objectives are referred to throughout the whole organization. | | V | | V |
| | 5 | The organization has formulated strategic objectives and Asset management objectives. There are all aligned and acknowledged as the methodology to substantiate the creation of value. | | | | |
| **4** | **In what way are you able to 'objectively' assess, and specify the impact of a maintenance activity on the operation of the total asset network?** | | | | | |
| | 1 | Asset data is completely fragmented, and is only requested for ad hoc maintenance activities. | | | V | |
| | 2 | There is an attempt made to structure the Asset data. However, this solely done within the disciplines. It does however link this data with financial information on the asset. | V | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 | There is an attempt made to integrate the Asset data across the disciplines. Moreover, there is a link with financial information of the asset, and maintenance measures. | | V | | |
| | 4 | Asset data is aimed at supporting the long term maintenance and financial requirements. It is structured to support the Asset management decision making process. | | | | V |
| | 5 | Asset data is extensive and correct. The Asset management decision making process is supported by its linkage with the maintenance and financial considerations. Moreover, the Asset manager is able to retrieve information relevant to cause and effect. | | | | |
| **5** | **Is the functionality of an asset taken into consideration in determining maintenance measures?** | | | | | |
| | 1 | The organization is not aware of the importance of a functional approach in maintenance, and does not support it. | | | | |
| | 2 | The organization is aware of the importance of a functional approach in maintenance, but sees a limited utility in it. | | | | |
| | 3 | The organization has a fragmented approach towards asset functionality. It is something in their mind during maintenance, but there are no formal structures in place. | V | V | V | |
| | 4 | The organization manages and controls on functions, and assets are analyzed technically and functionally. | | | | V |
| | 5 | The organization has fully decomposed his assets functionally, and has included it in his asset data system with the relevant linkage to other element. | | | | |

Appendix I, Section III – Validation transcript

# Interview: Den Haag (*Interviewee V.1)*

**Transcript Den Haag**

Datum: 7 maart 2017
Adres: Spui 70, Den Haag
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

# Interview: Utrecht (*Interviewee V.3)*

**Transcript Utrecht**

Datum: 10 maart 2017
Adres: Koploperstraat 50-52, Utrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Groot (meer dan 300.000 inwoners)

[*Confidential*]

# Interview: Dordrecht (*Interviewee V.4)*

**Transcript Dordrecht**

Datum: 21 februari 2017
Adres: Kerkeplaat 3, Dordrecht
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: Medium (100.000-300.000 inwoners)

[*Confidential*]

# Interview: Noord Holland (*Interviewee V.6)*

**Transcript Noord-Holland**

Datum: 20 februari 2017
Adres: Loevesteinplaat 2, Delft
Interviewer: Hoang Pham
Aanwezige: [*Confidential*]
Gemeente: /

[*Confidential*]

# Appendix J Theory

This section includes additional theory and body of text not used in the final version of the thesis.

## Appendix J, Section I – Changes on a governmental layer

As in many other sectors, the Dutch infrastructure sector deals with challenges in the public domain. This concerns for instance environmental and social issues, a changing market, and an increasing public participation. Simultaneously there is a strong rise in demand noticeable for public services, while the financial funds are not. Trends indicate that municipalities will receive even less funds from the central government in the future (Bekkers, 2016). This development requires the government to focus on their priorities, and separate the necessities from the desired objectives.

In December 2003 the Dutch government departments sent a letter to the Second Chamber asserting their vision on modernising the government (Graaf & Verdonk, 2003, pp. 1-2). They argued that the relationship between the citizens and the government was in need of a thorough reorganization. The fundamental idea was to reduce the responsibility of the government, as a 'welfare state', and shift the responsibility towards the market parties; creating a so called 'civil society'. This vision was driven by the belief that the government should focus on its core tasks and in addition should perform those tasks better and more efficiently. It created a strict division between policy and implementation within the governmental departments. As such Rijkswaterstaat (RWS) was appointed the executive agency of the Dutch Ministry of Infrastructure and the Environment, and thereby was strictly concerned with the execution of the policy.

Another change that took place at the governmental level was the decentralization of public tasks. Many public services were transferred to the lower governmental levels. Local authorities, including the municipalities, are major players in the Dutch governmental system. They gained more authority in their own local decision-making process as a result of the decentralization. Allers, Steiner, Hoeben, and Geertsema (2013, p. 37) stated that more than a quarter of all government spending stems from the incurred expenditures of municipalities. Based on the current expenditure pattern of municipalities, the forecasted budget deficit at the end of the period 2014-2018 is estimated to be around 4,8 billion euros (Allers et al., 2013, p. 26). Efficient use of limited public resources is vital to coop with the rising demand and expectations of (local) public services. As mentioned before, municipalities need to focus on their core objectives.

## Appendix J, Section II – Value

The highest responsible body for infrastructure in the Netherlands is the "Ministry of Infrastructure and the Environment". According to their organizational description they are committed in "*improving quality of life, access and mobility in a clean, and safe and sustainable environment"* (Government, 2016). It shows that their pillars of public values are: Quality of life, Safety, and Accessibility of infrastructure in the context of a sustainable environment.

It is a challenge for the managers of infrastructure assets, to come up with an optimal maintenance strategy and in addition determine the required costs. The foremost reason is that investments made for maintaining assets are quantifiable, while the derived benefits are not (Al-Najjar, 2012, p. 116). As a maintenance budget consists solely of costs, it is easy to track

expenditures towards assets in cases of failure, representing maintenance deficiencies. However, when a failure does not occur or is reduced, a direct causality with maintenance is much harder to attest (Al-Najjar, 2012, p. 116; Waeyenbergh & Pintelon, 2002, p. 299). This suggests that in cases when maintenance is effective (good maintenance), and thus prevents functional breakdowns, it is hard to designate the direct effects on the system, and asset network. Vice versa it's hard to substantiate the necessity of a maintenance activity in a quantifiable manner. In addition these maintenance considerations should be made effectively, where the most gains in terms of Quality of life, Safety, and Accessibility can be achieved.

Historically, theories regarding value have been covered extensively. Philosophers in ancient times have written about the concept of value, but mainly from an intrinsic perspective. According to an admission in the Stanford Encyclopedia of Philosophy, '*the intrinsic value of something is said to be the value that that thing has in itself…and is crucial to a variety of moral judgement"* (SEP, 2004). This perception of value regards the question whether something is morally right or wrong. Other authors differentiate intrinsic value from instrumental value. The latter is regarded as value of something as a mean to obtain something else. In this definition value is given to the relation that object has with a certain goal or object. In the context of this thesis, infrastructure is seen as an asset that has an instrumental value, as it is used as a mean to reach a higher goal.

***Social Value***

Value theory has presented different understandings of value. Simply put, value is a concept given to physical or abstract objects by people. If value arises from the belief it collectively benefits a whole society, and moreover they are able to affect it through decisions, it is called Social value. The way people are able to participate in the decision making process are for example through political voting, and by market transactions. A key notion is that there is no need that the stance on a particular social value is shared by the whole society or even the majority of them. Individuals, such as private parties, could create social value that is specifically catered to them. The emphasis of social value lies on a suitable allocation of limited resources, for which a given set of individuals could derive a maximum utility.

In the infrastructure sector, a great importance is put on safety, quality, and availability. To keep the asset on a certain performance level, maintenance is vital. However maintenance leads to asset downtime which negatively impacts the availability of the infrastructure. It indicates that different values in social value is conflicted with each other.

***Public value***

Public value is seen as a subset of social value, and moreover is widely supported by the public (Figure 13-1). Social value can be achieved by public bodies or private parties. In particular situations it is justified that government intervention is needed. Especially when we regard non-rivalry goods leading to public value. Non-rivalry implies that "*the optimality of the marginal costs of the good provision equate the sum of the marginal willingness to pay summed over all consumers*" (Lijesen & Shestalova, 2007, p. 17). Moreover, its utility by one users does not affect the utility of another. There is a collective agreement that the government is responsible for the assurance of public value, as it is infeasible or undesirable to leave this to the market.

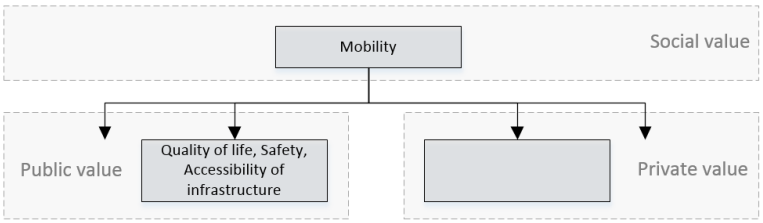



**Figure 13-1 Hierarchy of Social Value**

In contrary to monetary value which only regards the economic worth of an object, value in this thesis is addressed as the relation an object has with a certain goal or other object. This is in line with the rationale on value formulated by Markman and Brendl (2000, p. 98), who stated that "*the perceived value of an object is affected by its relationship to the active goal*". An example for value given is, an infrastructure asset that has a value for an organization since it is used to reach a higher objective; e.g. improving mobility. It enables us to understand the relation between performance, capability, appeal, risk, and costs. Pries and Quigley (2012, p. 4) expressed value as an approach that maximizes the function of an asset in relation to its costs:

$$Value = \frac{PERFORMANCE + CAPABILITY}{COSTS} = \frac{FUNCTION}{COSTS}$$

In this equation the capability is the extent the asset is able to meet the required performance. Due to the strong relationship between performance and capability, the term function is introduced which is the sum of those (see also § 1.3). The equation also reveals that value can be increased in two ways; (1) reducing costs, or (2) increasing function. Thus an organization aims for the lowest costs given a certain function. The mathematical equation suggests that value is quantifiable, but practice shows that this concept is still hard to grasp.

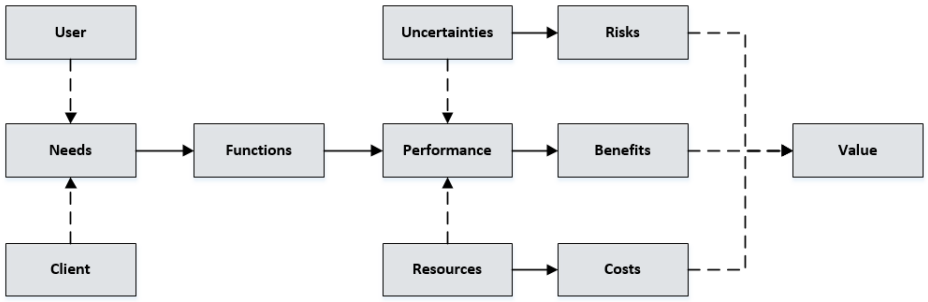



**Figure 13-2 Relation Needs and Value, adopted from Goldbohm (2016, p. 26)**

However, we could argue that using a value chain we are able to assess how value is impacted by functions, performances, and thus activities. Figure 13-2 illustrates that the value of an asset can be assessed by evaluating its relation to the risks, benefits, and costs. However, this only regards the value of one particular asset towards the need of an organization. In the Asset management mindset there needs to be a direct link to the value of an organization as a whole. The line-of-sight as described in Figure 1-4 specifies that value first most, should be defined on a corporate (strategic) level. Thereafter the strategic needs (objectives) can be extracted. Figure 13-2 is adapted based on the line-of-sight, and is presented in Figure 13-3. The adjusted figure shows the relation between value and performance, and demonstrates that organizations are able to indicate how specific assets contribute towards the corporate values (feedback loop), but also how the whole asset network contributes towards it (reverse direction). Based on the line-of-sight model by Huerne and Willems (2011) the fundamental idea is formed, whereas *Functions* act as a bridge between value and performance.

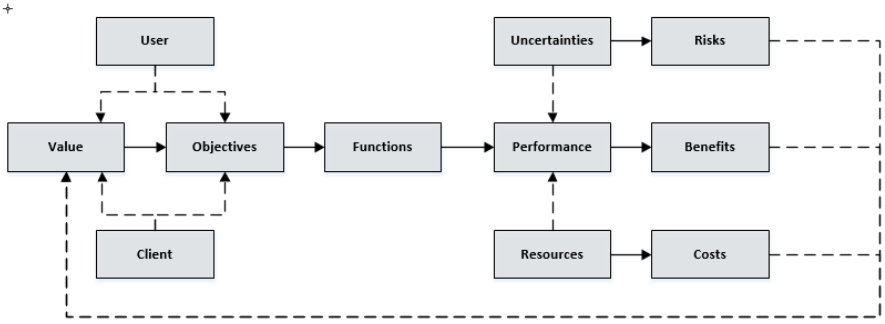



**Figure 13-3 Relation Value and Performance**

### *Value in Asset Management*

In the Netherlands the “Ministry of Infrastructure and the Environment” in collaboration with RWS have developed a risk-driven maintenance concept that describes all the primary performances of all the functions of a system called; RAMSSHEEP (Wagner & Van Gelder, 2013, p. 703). It stands for (Rijkswaterstaat, 2012):

- **Reliability**: probability of a system failure in which it can’t fulfill its intended function
- **Availability**: the time period in which the system fulfills its intended function
- **Maintainability**: the simplicity the system can be kept functional
- **Safety**: the lack of human injuries during the operation and maintenance of the system
- **Security**: the safety of the system against undesired external influences: e.g. vandalism.
- **Health**: the systems impact on physical, mental, and societal health
- **Environment**: impact system on its direct environment (physical)
- **Economics**: financial picture related to the costs and benefits
- **Politics**: rationale on all aspects above

The RAMSSHEEP analysis can be used at the tactical level to evaluate the correlation between the criteria aspects, and enables us to define, determine, and monitor the performances of the system (Rijkswaterstaat, 2012). With the RAMSSHEEP criteria, Asset managers are able to create better maintenance strategies for their assets.

In addition to the applicable regulations and directives, the direction and policies at the strategic level of an organization is vital for defining value. Especially, for public asset owners, such as municipalities, defining and creating value is important as the public is directly affected.

There are vast differences between public and private sectors. A major difference for local governments, is that municipal income generation activities are carried out with the sole purpose of fulfilling their public function (VNG, 2010, p. 11). Fundamentally, there is an incentive to reduce costs and improve the way assets with (vital) functionalities are managed. Local public authorities should demonstrate how they have spent the funds to create value for the public, as public resources are involved.

It is important that value, and strategic objectives are defined with consent of the public, and moreover explicitly. Strategic value consists of both public values, and corporate values. Strategic objectives are subsequently derived from strategic values, and various policy documents. Such policy documents includes, but is not limited to (Gemeente Waddinxveen, 2015; Randstedelijke Rekenkamer, 2009, p. 14)

- College program
- City vision
- Municipal policies and plans (e.g. Traffic and Transport plan, Mobility plan)

- Adaptation strategy
- Sustainability vision
- Structure vision

In § 1.1 it was stated that the pillars of public value of the "Ministry of Infrastructure and the Environment" revolves around: (1) Quality, (2) Mobility, (3) Safety, and (4) Sustainability. In most cases these public values are adopted in a modified form by other governmental organizations. As such the municipality of Rotterdam adopts the following strategic values (public values + corporate values): Economy, Availability, Safety, Image, Quality, and Sustainability & Health[17]. Nevertheless, almost all the interviewed municipalities struggle with the quantification of value, and explicitly linking them to the activities. As a result they're not only unable to define the value of a certain asset, but also how their whole asset network contributes towards the strategic values. Value is a vital aspect within Asset management. Figure 13-3 depicts a clear approach for value determination and creation, but municipalities are in need for a practical translation.

## Appendix J, Section III – Planned maintenance

Throughout the years RWS has become a more public-oriented organization and is collaborating increasingly more with market parties. Following the expressed ambition in their business plan "Agenda 2012" they are eager to outsource their predominant role as an executing agency, and instead focus on directing and controlling private parties (Ministerie van Verkeer en Waterstaat, 2008). This development is also noticeable in the other organizations in the public domain, whereas provinces and municipalities take on a controlling role, and market parties strengthen their executive role with more responsibilities.

As a derivative of the shift, a professionalization of the maintenance process is in progress in the civil sector. Gradually, we're shifting from 1-on-1 asset replacement projects towards a combination of "*functional preservation, functional alteration and largely functional improvements*" in our core maintenance strategy (Koshiek et al., 2015, p. 15). Koshiek et al. (2015, p. 15) argued it is a shift from excessive asset replacements towards what he calls "*transformation opportunities*". The importance of the latter is to ensure that the creation of value from assets is enabled.

In a policy document regarding the maintenance of public space in the Municipality of Breda, the municipality stated that the maintenance of civil engineering works, and waterways were mainly performed reactionary (Gemeente Breda, 2014, p. 14). The reactive maintenance strategy originated from the lack of available funds for maintenance, and caused a lot of overdue maintenance (Gemeente Breda, 2014, p. 9). The accumulation of overdue maintenance is an issue many municipalities in the Netherlands struggle with (Gemeente Ede, 2016, p. 11; Gemeente Rotterdam, 2015, p. 41). Moreover, there is a trend noticeable, including in Breda, whereas the maintenance budget is declining even more (Rekenkamer Breda, 2013, p. 3). The lack of funds suppresses the level of maintenance, and overdue maintenance cannot be tackled in a timely fashion. The technical condition of roads, public lighting, and civil engineering structures could decline further, and hamper the quality of the public space within the municipalities. In order to coop with the decreasing funds in an environment with overdue maintenance, maintenance activities should not only be proactive, but also critical for the municipality (Randstedelijke Rekenkamer, 2009, p. 13).

[17] Empirical research; Statement based on preliminary research in the municipality Rotterdam

# Appendix J, Section IV – Measurable Objectives

The VNG (2015, p. 13), a Cooperation Agency of the Association of Netherlands Municipalities, starts their report concerning the future of municipalities with the sentence; "*adding social value is the core objective of the public administration*". As a mean to create social value, all policies and decisions throughout the governmental levels revolve around this concept. Therefore strategic objectives need to be defined to align the operations of the municipality.

Chandler (1966, p. 13), a Harvard professor and long-time researcher on management structures, defined *strategy* as "*the determination of the long-term goals and objectives of an enterprise, and the adoption of courses of action*". At the highest level of an organization the strategic objectives define the course of action. However, on the operational level of an organization, strategic are too broad and ambiguous. Therefore operational objectives need to be defined. Petryni (2011) argued that the most important difference between the strategic and operational objectives is its timeframe. The operational objectives can be seen as project benchmarks that have to be met short-term. Another argument made by Petryni is that "*an organization is unlikely to achieve a strategic objective if it fails to effectively translate it into workable operational objectives*". It validates the rationale made throughout this report that there needs to be an explicit relationship between strategic objectives and operational objectives.

In the municipality of Nijmegen the operational objectives are defined on two levels; with outcome-objectives, indicating the effects on society, and with output-objectives, indicating the means of production of an organization (Pruijsen, 2004, p. 4). A methodology that aids in defining the operational objectives in a measureable way is the SMART-principle. This principle stands for Specific, Measurable, Acceptable, Realistic, and Time-bound (Roozenburg & Eekels, 1991).

- **Specific**: The objectives are formulate unambiguous.
- **Measurable**: The objectives are measurable, as it contains (1) one or multiple measurable indicators, and (2) a target value (BZK, 2003).
- **Acceptable**: Indicating there is sufficient support for the fulfilment of the objectives.
- **Realistic**: The objective is feasible
- **Time-bounded**: Provided with a time aspect.

Using this approach the municipality of Nijmegen is, according to them, able to define the required maintenance activities and in addition are able to answer the practical questions such as "*What is our goal*", "*What do we need to do*", and "*What will it cost*" (see Figure 13-4). However, if we compare Figure 13-4 with Figure 1-1, we can argue that some structure is lost in the practical line of sight. The absent terms, Functions, System, and Performance are grouped in the output objectives under the operational objectives. It is the question whether a strict decomposition would lead to a higher effectiveness.

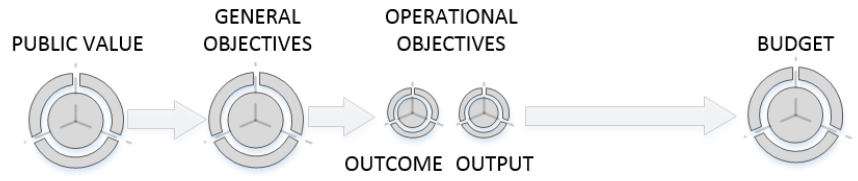



**Figure 13-4 Practical line of sight**

# Appendix J, Section V – Functions

Functionality regards; how a system should perform, how it should operate in certain scenarios, how it should interact with other systems, and so on (Forsberg, Krueger, Walden, & Hamelin, 2011, p. 123). The ISO/IEC 15288:2008 – Systems and Software Engineering - Systems Life Cycle Processes – defines the system as "*a combination of interacting elements organized to achieve one or more stated purposes*"(International Standards Organisation, 2008). Following this definition we can argue that a system consists of multiple system elements with an interaction (relation) with other elements that fulfills a (part of a) function. In theory we are able to connect every system to another. However, not all of these systems might fall within the scope of the project, thus is not included in the system of interest (Figure 13-5).

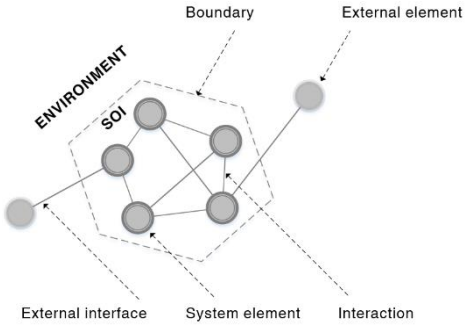



**Figure 13-5 System of interest (SOI), adapted from Forsberg et al. (2011, p. 12)**

In infrastructure we can broadly define a number of functionalities the infrastructure has to meet. For such they provide accessibility by linking areas with each other through a network of individual assets, and in addition aim to improve the safety of an area. Policy documents usually contain these functionalities using terminology such as ecological link or infrastructural connection (Provincie Zuid Holland, 2006, p. 21). When we refer back to functionalities we could argue that there is a strong connection between functionalities and objectives. Viola, Corpino, Fioriti, and Stesina (2012, p. 71) stated that a functional analysis is used to "*guarantee that all necessary components are listed and that no unnecessary components are requested and to understand the relationships between the product's components*". References to necessary and unnecessary components indicate a concept of effectiveness. Moreover, we could argue that in order to determine which and how assets could add value to the organization, insight into these necessary, unnecessary components, and relationship between those is a necessity.

# Appendix J, Section VI – Impact framework

Before we can say anything sensible about impact, it first needs to be identified. An impact categorization is used which structures the impact factors using a scheme listing the primary categories of impact. In this research three master categories and their associated sub-categories of impact are adopted (Table 13-1).

| ECONOMIC IMPACT | EXTERNAL IMPACT | SOCIAL IMPACT |
|---|---|---|
| Competitive advantage | Compliance with regulations | Safety |
| Productivity and efficiency | Stakeholder satisfaction | Organization culture |
| Managing risks and uncertainty | Perception by others | Innovation (and human resources) |
| Operation and Maintenance | | Vagueness of tasks |
| Value creation | | Organizational policies |
| Business focus | | |

**Table 13-1 Impact master categories and sub-categories (approach adapted from CSIRO (2015, p. 8))**

The master category *Economic impact* on an organization represents the capability the organization is affected by Asset management in areas such as financial costs, opportunities or other means of economic interaction. *Social impact* embraces the effect of how the activity

has effect on the social fabric of an individual or organization. The last master category includes the *External impact*, which shows how external bodies are affected by the implementation of AM by the organization.

The researcher needs to understand that there is a distinction between organization's resources and capabilities. Grant (1991, p. 131) stated that resources are the productive assets owned by an organization, while capability is the potential what an organization is capable off. In other words the collective use of the resources creates organizational capability. Figure 13-6 shows that resources and capability are connected to gain competitive advantage through the usage of a strategy; i.e. Asset management. It also shows that misalignment between an organization's strategy and the usage of resources could negatively impact the value creation.

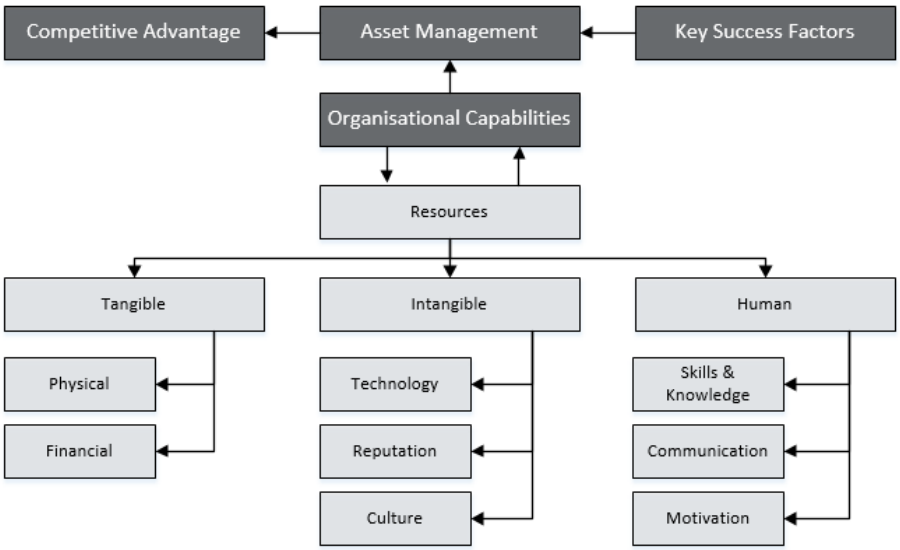



**Figure 13-6 Link Organizational capabilities, resources and competitive advantage (Grant, 1991, p. 131)**

The number of specific research papers on Asset management impact in an organization, is limited, but those on the impact of Asset management in general, or more popularly formulated the benefits, motivations, and challenges of AM are plentiful. However, this raises the question on what the author understands under Asset management. In addition, an organization is familiar with and uses various strategies, and management systems. A commonality is that the main objective of such strategies is usually very similar in that they strive for more efficiency, effectiveness, structure, or improve quality. Strictly speaking it's very complex to isolate and identify the impact of only Asset management related input in an organization. In an attempt to avoid this vagueness the core function identified in § 3.5 are used to identify the impact of Asset management. By looking at each core function separately we will gain insight in how it benefits the whole organization. A separate analysis is introduced that focusses on the impact of integration and implementation of AM.

The Asset management core functions used for this analysis might have a direct effect on the resources of the company or on the organizations capability. Grant (1991, p. 131) has illustrated (Figure 13-6) that the resources can be divided in three categories.

- **Tangible**: Impact on the assets and financials
- **Intangible**: Impact on a firms technology, reputation, and culture
- **Human**: Impact in the skills, communication and motivation

***Tangible resources***

Tangible resources are predominantly physical resources. Examples are the physical assets or the financial resources. The impact of a core function on an organizations tangible resources could lead to a competitive advantage. This might happen when opportunities can be created, or if existing resources can be made more cost-effective.

***Intangible resources***
The intangible resources includes the non-physical resources. However, for some companies these intangible resources, such as reputation and culture, have a greater effect on a company's value. Especially in governmental organization's the way the public perceives the organization is reflected in their preparedness to pay for the service provided by it.

***Human resources***
The human aspects within resources regards the knowledge and efforts of its employees. Like the intangible resources, the human aspects are hard to quantify. In recent years the social and emotional skills of employees are regarded highly. It involves identifying the set of skills, attitude, knowledge, motivation, and values that are linked to the technical and professional abilities to perform well (Grant, 1991, p. 133). Having the right people at the right location in the company could be regarded as one of the most important assets of an organization

The focus on resources in the impact analysis enables us to make a statement about a firm's potential capacity to use resources for a desired objective; the organizational capability. The leading indicators, core functions mentioned in Chapter 3 are adopted and used as search entries to identify the impact factors outlined in literature. The impact literature evaluation is listed in Appendix F.

# Appendix J, Section VII – Different municipal structures

Aardema et al. (2009), who have researched the integration stimulus of different municipal organizational models, recognized three distinct municipal structures in the Netherlands; the secretariat model, the sector model, and the management model. Generally speaking, the secretariat model was used until the 1980s, thereafter the sector model was adopted in the 1990s, but nowadays the most prevalent model is the management model (Aardema et al., 2009, p. 1).

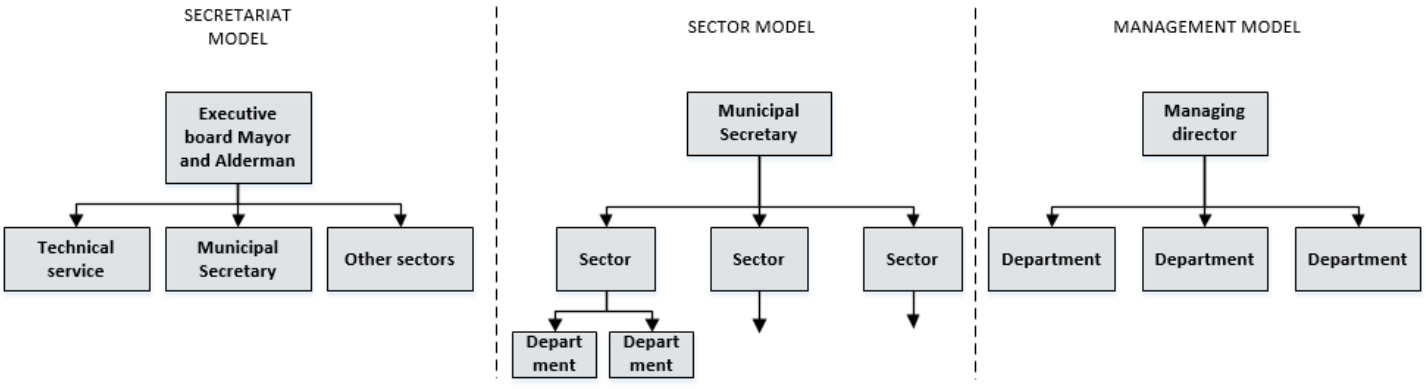



**Figure 13-7 Municipal organizational models, adapted from Aardema, Korsten, Bekke, and Breed (2009, pp. 4-9)**

In the secretariat model, the central government administration consists of the municipal secretary under whom the policy is created and monitored. However, according to Aardema et al. (2009, p. 3) this model led to a "*competitive struggle*" between the secretary and the executing technical service. When an advice was asked by the Executive board, both departments gave conflicting opinions, counteracting an integrated alignment between policy and operation. In the

sector model, the policy development and operation are grouped into sectors. Aardema et al. (2009, p. 5) emphasized that it "*suppressed the ability to work and think on a strategic level*", as the sector managers were only held accountable for their own sector. It resulted into a more fragmented organizational model in practice. The last model is the management model which was adopted to comply with the rationale to be more effective and more professional. In this structure the municipal secretary (also referred to as the general director), is responsible for all departments ranging from policy, operations, to back office. Important to acknowledge, is that in this structure a department programme control is introduced, and outsourcing to market parties is facilitated. Nevertheless, Aardema et al. (2009, p. 9) argues that even in this model, which focuses on cooperation, an integrated approach in practice is not always attained. First of all, it is 'hard to change the management approach when one is not used to it', 'within the departments a natural evolution occurs wherein new teams are formed', and 'communication to the management suffers as the structure, divided in departments, differs from the sectorial portfolios of the aldermen' (Aardema et al., 2009, p. 9). In conclusion on the integration of the organizational structure Aardema et al. (2009, p. 10) claims that a change in the organizational model doesn't greatly improve integration as theory suggests, on the contrary when it is pushed through the opposite occurs. The authors cited that the employees are aware of their responsibilities, and know how to find each other. This is part of a self-correcting mechanism applicable to all organizations (Homan, as cited in Aardema et al. (2009, p. 11)).

The notion stated by Aardema is to a certain extent aligned with the change management literature in Chapter 5 , where it was concluded that successful change heavily depend on social factors of which employees were crucial. It indicates that in order to improve integration the change should focus on work relations, and culture, instead on merely technical factors such as an organizational model. Regardless, the municipal model is crucial in the sense that it is a supportive infrastructure that could facilitate integration when the work processes, and ideologies of the employees are aligned.

## Appendix J, Section VIII – Research method

A survey strategy is the preferred approach to gain a broad understanding on the research subject. The conclusions in a survey is drawn from large quantities of research units, and a verdict is made on the statistical significance of a pattern. An experimental strategy is used to analyze the effects of a method on the condition of the research subject. The conclusion is drawn upon the causality of the effect X on Y. A case study strategy is performed to gain a detailed understanding of the subject by performing interviews, reviewing documents, and by observation. A funded theoretical approach strategy has the objective to further the theoretical understanding of a subject by combining elements of empiric and theoretic research. The last research strategy mentioned by Verschuren is the desk research which focuses on existing literature to understand the research subject. In addition to the strategies mentioned by Verschuren and Doorewaard (2007, p. 164), there are three core guidelines in a research; the research methodologies:

- Width versus detail
- Qualitative versus quantitative
- Empirical versus desk research

The majority of methodologies are considered qualitative in nature, as the observed and analyzed data can be observed, but not measured. In a way its aim is more focused on understanding the complexity of a problem. One of the methods used is the *Action research* which is an applied research in which the researcher tries to broaden the current theoretical knowledge and at the same time tries to develop a practical solution. It can be used to bridge the gap between theoretical knowledge and practical implementation, as the researcher

develops a (theoretical) solution for a practical problem. Action research "*involves the client in data gathering but is driven by the researcher's agenda"* (Schein, 1995, p. 13).

Schein (1995, p. 11) mentioned that a more "*clinical approach to action research"* is showed in *process consultation.* It is based on the assumption that only the client knows what the core problems are, and what the most effective solutions are within his organization for a particular problem. However, a key observation in a research following the process consultation is that the problem is not yet clearly defined from the start. There is a problem, but the exact nature of the problem is not known among the researcher and client. In a sense this is a characteristic of an exploratory research. The role of the researcher or consultant is then to guide the client through the research process using four key interventions (Schein, 1995, p. 11):

- **Pure inquiry:** What is going on?
- **Diagnostic inquiry:** Why did that happen?
- **Action oriented inquiry:** What did you do?
- **Confrontive inquiry:** Have you considered..?

As the research problem was unknown during the initial stages of the process, some components of process consultation were used to identify the problem. The four inquiries above were used as the main directive during the interviews, and in the undocumented early conversations with subject experts. Moreover, they are used as a support to identify and formulate recommendations for the problem.

# Appendix J, Section IX – Legal framework of maintenance

In the Netherlands RWS, the provinces, municipalities, and water boards are the owners of infrastructure portfolios. The legal framework regarding the duty of care of the infrastructure assets is set out in the Civil Code. Article 6:174 BW states that the asset owner is legally accountable for any incurred damages by the assets users. To suffice to the duty of care the asset owner needs to maintain a continuous process consisting of data management, quality evaluation to guidelines and policy, and maintenance measures. It indicates that preventive maintenance, inspections, citizen reports, and especially well-timed maintenance are key components which are reviewed by external parties. When the municipality is unable to sufficiently demonstrate he meets the criteria, he will be liable for the incurred damages. In the following section a short list of statutes are mentioned.

***Environmental Law (****Omgevingswet****)***
Many examples on the duty of care make references to the roads act (wegenwet) as an example for infrastructure, as such in §1.1. However, in 2015 the Second Chamber adopted a legislative proposal, Environmental Planning Bill, that combines 26 laws and regulations on the living environment (NEN, 2015). Starting in 2018 this law is put into service. Familiar laws that will be included are the roads act (wegenwet), Flora and Fauna act, water law, Infrastructure act, and Noise Abatement act.

The guiding principles leading to the adoption of the replacement law, is that it simplifies the execution of projects, the old acts are reviewed which leads to more room for sustainability, area-specific decisions, and a sufficient qualitative execution of projects.

**CROW guidelines (***Crow richtlijnen***)**
The main objective of the municipality is to properly manage maintenance on assets. Following this practice will reduce the number of incurred damages claimed by the infrastructure users. Many municipalities (i.e. Interviewee 2, 4, 5, 7, 8) follow the quality guidelines set out in the CROW. This document is drafted upon the assumption that maintenance is performed structurally.

The CROW publication 185 “*Handboek aansprakelijkheid beheer openbare ruimte*”, defines the guidelines on the public area to prevent liability of damages. The CROW publication 147 “*Wegbeheer 2011*” defines in which manner the assets need to be maintained. It deals with the planning, budget, and measures.

The CROW quality levels, often copied by the municipalities, differentiates five different quality levels;

- A+ (very high)
- A (high)
- B (basic)
- C (low)
- D (very low)

An asset or an area is given a specific quality level to which it has to be maintained. This approach is a practical, but on the other hand also an objective method to evaluate the state of an asset.

A shortcoming of the guidelines is a result of the principle supply and demand. Municipalities are reviewed based on their fulfillment to the quality levels. Mention of influences of the strategic objectives, or the organizational objectives in their maintenance is often omitted. Therefore, many municipalities disregard the strategic linkage between the objectives and the tactical level. The same observation is made among other companies not being public organizations (Y. C. Wijnia & Herder, 2010, p. 9).

# Appendix J, Section X – Functions in SE

In the line-of-sight model, function refers to functions as used in Systems Engineering. The methodology is predominantly used in new development projects, in which it has shown a positive impact on reducing the projects costs. ***Systems Engineering*** (SE) is a methodology that concentrates on managing and designing complex engineering systems, creating structure to store important issues and it plays an important role in data management (Werkgroep Leidraad SE, 2009, p. 50). Its most valuable contribution is that it also enables us to identify opportunities and selecting the most optimal solution (Forsberg et al., 2011, p. 21).

According to Oostinga (2014, p. 47), there are two important roles within SE; the role of ***function*** and ***fulfiller***. A function describes an activity the system has to perform. These activities are carried out by components of a system; the fulfillers (objects). The difference is exemplified in Figure 13-8.

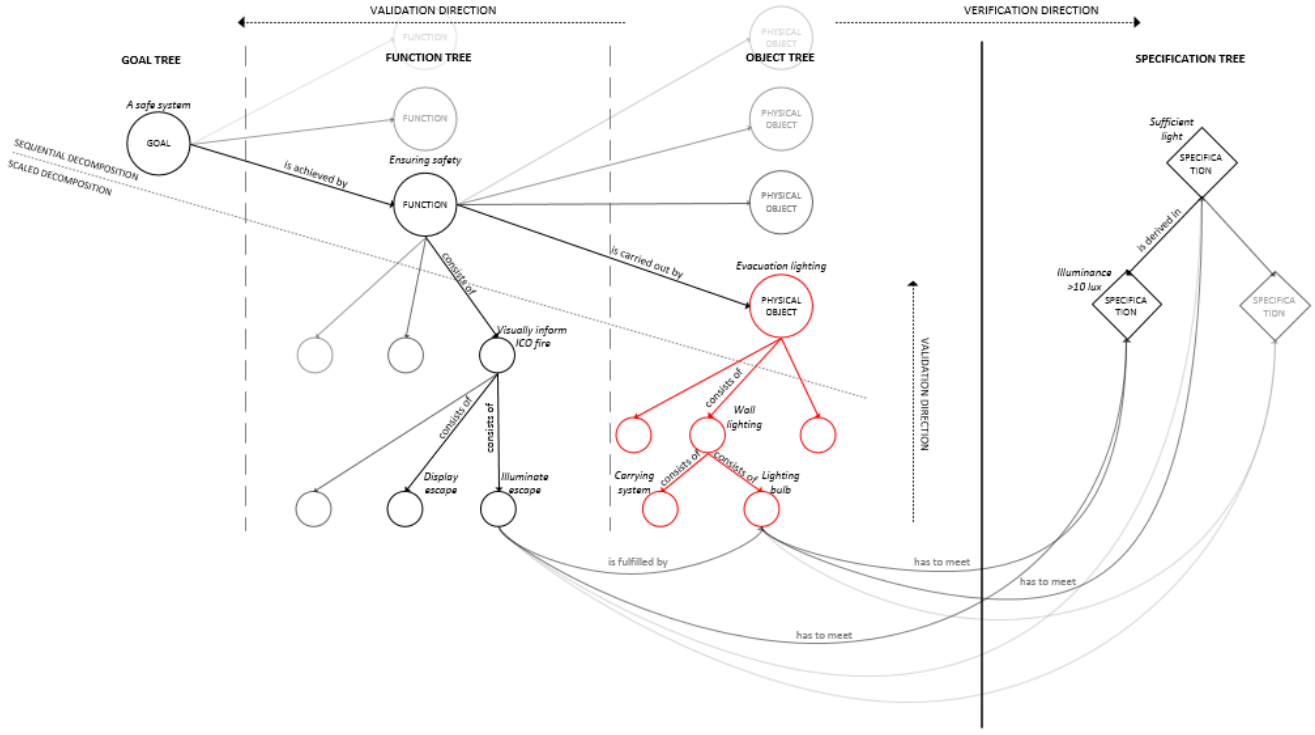



**Figure 13-8 Systems engineering model, adopted from Oostinga (2014, p. 47)**

Figure 13-8 shows a section of a decomposition from the goal '*safe system*' to a fulfiller '*evacuation lighting'*. In this model the relation between objective, and object is shown, as the goal is decomposed in a number of functions set out in a structured function tree. The object tree is referred to as the function fulfiller of a particular function. In this case the function '*ensuring safety'* is partially fulfilled by an '*evacuation light*'. Such as in the line-of-sight model, performances and requirements can then be connected to a particular asset. The specification tree is used to clarify the goals, functions and objects with specific measures. The way this model is built upon an SE mindset could be used in Asset management as well.

# Appendix J, Section XI – Capability maturity model

The Capability maturity models arose from the beginning of the 20th century across various industries. One of the key influencers of the Capability maturity models for the software industry was created by Paulk (1993). Its purpose was to provide guidance to software organizations on "*how to gain control of their processes for developing and maintaining software and how to evolve towards a culture of software engineering and management excellence"* (Paulk, 1993, p. 5). He differentiated 5 different levels of software process maturity ranging from (1) Initial, (2) Repeatable, (3) Defined, (4) Managed, and (5) Optimizing (Paulk, 1993, p. 8). Since, many other fields of industries have adopted their own tailored form of maturity models to reach process excellence. The works of K. Brown et al. (2015) is based on this foundation, and also discerns 5 different maturity levels. The AMCaMM model consists of three steps (Figure 13-9).

In the first step the organization needs to identify the AM process area he wishes to answer the questions for. K. Brown et al. (2015, p. 2) identified 25 different process areas within Asset management including "*organizational governance, service delivery planning, knowledge management, and more*".

In the second step the questions related to the process area are answered. There are 5 different answer possibilities, ranked from 1 to 5, indicating the maturity levels.

In the last step the answers are visualized in a graph (Appendix F). in the end the organization could grasp where he stands on the maturity scale, and has insight in which process areas need improvement.

The model enables the organization to conveniently assess their own Asset management process.

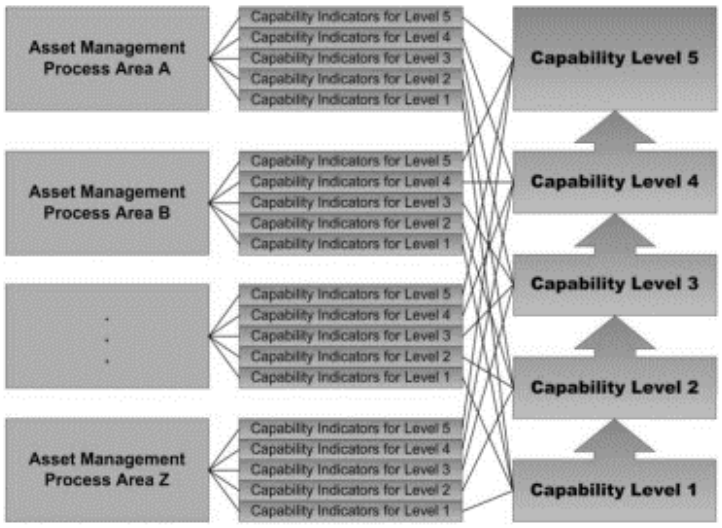



**Figure 13-9 AMCaMM (K. Brown et al., 2015, p. 2)**

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