Increase Quality through Information Management

Designing a plan for implementing an Information Management System with Integrated Quality Management for a contractor

MSc Thesis Construction, Management & Engineering
M.C. (Martijn) van Leeuwen
December 2013
# Colophon

## Thesis

**Title:** Increase Quality through Information Management  
**Subtitle:** Designing a plan for implementing an Information Management System with Integrated Quality Management for a contractor  
**Location:** Delft  
**Date:** December 2013

## Author:

**Name:** M.C. (Martijn) van Leeuwen  
**Student number:** 1304070  
**E-mail address:** martijnleeuwen@hotmail.com  
**University:** Delft University of Technology  
**Faculty:** Civil Engineering and Geosciences  
**Master track:** Construction, Management & Engineering

## Academic supervisors:

**Prof.dr.ir. M.J.C.M. (Marcel) Hertogh**  
Delft University of Technology  
Faculty of Civil Engineering and Geosciences  
Professor Infrastructure Design and Management

**Dr.ir. A. (Alexander) Koutamanis**  
Delft University of Technology  
Faculty of Architecture  
Associate Professor of Computational Design

**Dr.ir. G.A. (Sander) van Nederveen**  
Delft University of Technology  
Faculty of Civil Engineering and Geosciences  
Assistant Professor BIM for integrated design

## Industry supervisors:

**Company**  
Mobilis B.V.  
Fascinatioboulevard 522, 2909 VA Capelle a/d Ijssel  
+3155-5382222

**Ing. J.R. (Rutger) van der Noort**  
Mobilis B.V.  
Building Process Specialist

**Ing. M. (Marjolein) van Beek**  
Mobilis B.V.  
Quality Manager
Preface

For graduation in the Master Construction, Management & Engineering (CME) at the Delft University of Technology (DUT) it is required to finish with a graduation thesis. In front of you lies the thesis with the title “Increase Quality through Information Management”. With a bachelors in Civil Engineering this would not be the first topic to come to mind, but it proved to be a very interesting subject during the graduation process.

Quality Management is a topic that was not completely clear for me at the beginning of my graduation. This is the first topic that I learned a lot about and now I realise it's a very important part of the construction process. At the start of this thesis the topic Information Management sounded clear to me, but also during the graduation I realised it is handled differently within a contractor than I thought. Therefore it was really useful to execute this thesis at the company. Also, the implementation of a new software tool that leads to a change in the way employees have to work is really useful to research; there is a lot to take care about if you want to change the way people work. In the end, it was really informative for me to do research on these three subjects and try to combine these.

This thesis was executed at the company Mobilis B.V., a civil engineering contractor. The first thing that attracted me to this company were the large infrastructure projects the company is executing. It is really interesting to see how these projects are executed, but also how a design for such projects develops. Furthermore, I received a lot of support of colleagues during my graduation which helped me a lot. I would like to thank the Quality department, the Building Process department and especially my supervisors from Mobilis, Marjolein van Beek and Rutger van der Noort, for their support and interesting discussions during my graduation.

I would especially like to thank my graduation committee, Marcel Hertogh, Alexander Koutamanis and Sander van Nederveen, for their help and support during the most important period of my study.

Finally, I would like to thank my family and friends for the support during my complete studies and especially for the support during the last nine months; the finishing of my studies with this master thesis.

Martijn van Leeuwen

December 2013
Summary

Introduction
With construction projects there is a shift in responsibilities from client to contractor, which means that the contractor is earlier involved in the construction processes. This makes the contractor more influential, but makes the project for a contractor more complex. To manage these construction projects a contractor has five ‘control factors’: Money, Organisation, Time, Quality and Information. ‘Information’ and ‘Quality are chosen for this thesis to research and more specifically, how to integrate these two factors. Information Management Systems (IMS) and Quality Management Systems (QMS) are separately available for contractors, but combined systems are not. To improve the activities of a contractor the implementation of a combined system is researched. Therefore the following research question is composed: How to efficiently implement an Information Management System integrated with the processes of the Quality Management System within a contractor and its projects?

Literature study
To answer this research question a literature study is undertaken to clarify what Quality Management and Information Management is, how it is used in the construction industry and why it is necessary. Quality management is a system by which an organisation aims to reduce and eventually eliminate non-conformance to specifications, standards and customer expectations in the most cost effective manner. In the construction industry a QMS is mostly a collection of processes that have to be followed to come to a sufficient design and construction that meets the requirements of the client.

Information Management in the construction industry is often executed according to the method Systems Engineering (SE). SE is used to structure the requirements and the information during a project; it makes communication between client and customer easier. An Information Management System is a centralised information system that is accessible to all parties in a construction project. Because of the large amount of information during a construction project, it is important to have the right information available for the right person.

To create a framework for the success of the implementation of a combined IMS with QMS 26 Success Factors (SF) are derived from literature about the implementation of Information Management Systems and Quality Management Systems.

Quality Management and Information Management Mobilis
This thesis is executed at the civil contractor Mobilis; Mobilis is currently developing a combined IMS with QMS, named IMT-MS (Information Management Tool with integrated Management System). The goal of Mobilis with IMT-MS is to come to a successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent. IMT-MS is implemented in several projects in tender phase and the implementation of this system is considered a case study for this research.

Results and discussion
A survey is conducted among the user of IMT-MS; this survey is based on the Success Factors defined in the literature study. The questions are separated in six different subjects; Personal data, Development, Communication, Possibilities, Processes and Ease of use. The results of the survey are further discusses in five different interviews with the managers and developers of IMT-MS: the management director and the department heads. In the interviews the most important Success Factors and the topics that couldn’t be discussed with the end users in the survey are discussed.
In the discussion the results of the survey and interviews are further discussed to create a clear and consistent interpretation of the results. The conclusions of the discussion are further elaborated at the conclusion.

**Implementation plan – organisation level**

The success factors, interviews and the survey results in an implementation plan, which is structured in two parts: implementation on organisation level and implementation on project level. The implementation plan is written for a contractor that wants to start with a combined IMS with QMS. This is explained with Figure 1; considerations first have to be taken into account to start with development. After the development phase there has to be decided if the system should be implemented or further developed. After implementation phase, the implementation can be a success or not; if not, the system has to be further developed.

![Figure 1: Flowchart implementation plan organisation level](image)

The considerations that have to be taken into account before development are the current position of the company; the financial position, organisation culture, management board policy, competitors and computer experience.

With the development phase the following success factors are important:

- The goal of the system; possibly interlinked with the company goals
- Functions of the system
- Integration of processes
- Ease of use

During the implementation phase the following success factors are important:

- Clarity of the goal to the end user
- Top management support from management board, department heads and direct supervisors.
- Training and support before and during implementation
- A reliable system to create confidence among the end users.

**Implementation plan – project level**

On project level there first have to be decided (with considerations taken in mind) if the project is suitable for the system. After that there has to be decided on which phase the system has to start; the tender phase or realisation phase. Working with the system on the project should be evaluated after the project. This is visualised in Figure 2.

![Figure 2: Flowchart implementation plan project level](image)
Before the implementation of the system in a project the following considerations have to be taken into account to consider if the project is suitable for the system; uniqueness of the project, company share in the project, knowledge of employees, amount of disciplines involved and the contract form.

After the decision, the following success factors are important during implementation on project level:

- The goal should be clearly announced to the project team; including own company employees, but also employees of alliance partners.
- The project managers and department heads play a crucial role during implementation in a project; they should actively motivate the end users to use the system and ‘translate’ the vision of the management board to the end user.
- A different explanation should be given when the system is implemented in the tender phase or realisation phase; in the tender phase there should be focused on how to structure the requirements and in the realisation phase on how to create sufficient design detail and on the other processes that are included in the realisation phase.
- After the first explanation adequate and intensive support is necessary.

Conclusion

The conclusions are mainly based on the results, discussion and implementation plan.

- The goal of the to be developed system is very important for the development and implementation. The goal should be clearly introduced in the company and its projects.
- The influence of the management board, department heads and direct supervisors is important for the implementation; they should motivate the end user.
- The main points that should be mentioned during a first training are:
  - The goal of the new system
  - The processes of the company’s Quality Management System
  - Explanation how the system is structured.
- The primary functions should be first sufficiently developed and implemented before secondary functions are involved.
- This also counts for the involvement of clients and suppliers; they should be involved when the system is running sufficiently in the company.

Recommendations

- The research method including Success Factors can serve as a basis for further research on the topic or implementation of other systems.
- It can be useful to research how other industries handle this topic. On the other hand it can be useful to see if a system like IMT-MS is useful for other industries.
- The involvement of BIM (Building Information Modelling) can prove to be useful in this system.
Samenvatting

Inleiding
In de afgelopen decennia is er een verschuiving van verantwoordelijkheden gaande van de opdrachtgever naar de aannemer (of opdrachtnemer); dit betekent dat de aannemer vroeger in het ontwerpproces is betrokken. Hiermee krijgt de aannemer meer invloed, maar maakt het bouwprojecten ook complexer voor de aannemer. Om deze projecten te beheersen heeft een aannemer vijf projectmanagement paramaters; Geld, Organisatie, Tijd, Kwaliteit en Informatie. ‘Informatie’ en ‘Kwaliteit zijn de paramaters die gekozen zijn voor deze thesis om te onderzoeken en deze twee te integreren. Informatie Management Systemen (IMS) en Kwaliteit Management Systemen (KMS) zijn apart beschikbaar voor aannemers, maar gecombineerde systemen zijn niet beschikbaar. Om de activiteiten van aannemers te verbeteren is de implementatie van een gecombineerd systeem onderzocht. Hiervoor is de volgende onderzoeksvraag gesteld: Hoe kan een Informatie Management Systeem geïntegreerd met de processen van een Kwaliteit Management Systeem efficiënt geïmplementeerd worden binnen een aannemer en zijn projecten?

Literatuuronderzoek
Om deze onderzoeksvraag te beantwoorden is een literatuuronderzoek gedaan om te definiëren wat Kwaliteitsmanagement en Informatie management is, hoe het gebruikt wordt in de bouwnijverheid en waarom het nodig is. Kwaliteitsmanagement is een systeem waarmee een organisatie zich inzet om afwijkingen aan eisen, standaarden en klantvragen te reduceren en uiteindelijk te elimineren in de meest kostenefficiënte manier. In de bouwnijverheid is een KMS voornamelijk een verzameling processen die gevolgd dienen te worden om tot een toereikend ontwerp en bouwwerk te komen dat overeenkomt met de klanteisen.

Informatie management in de bouwnijverheid wordt vaak uitgevoerd d.m.v. Systems Engineering (SE). SE wordt gebruikt om de eisen en informatie tijdens een project te structureren; het maakt daarmee communicatie tussen opdrachtgever en aannemer makkelijker. Een IMS is een gecentraliseerde informatie systeem dat toegankelijk is voor alle partijen in een bouwproject. Omdat er tijdens bouwprojecten een grote hoeveelheid informatie beschikbaar is, is het belangrijk om de juist informatie bij de juiste persoon beschikbaar te hebben.

Om een kader te creëren voor het succes van de implementatie van een gecombineerd IMS met KMS zijn 26 succes factoren (SF) gedefinieerd. Deze zijn afgeleid uit literatuur over de implementatie van Informatie Management Systemen en Kwaliteit Management Systemen.

Kwaliteitsmanagement en informatiemanagement Mobilis
Deze thesis is uitgevoerd bij de civiele aannemer Mobilis; Mobilis is momenteel een gecombineerd IMS met KMS aan het ontwikkelen, genaamd IMT-MS (Informatie Management Tool met geïntegreerd Management Systeem). Het doel van Mobilis met IMT-MS is om tot een succesvolle projectbeheersing overeenkomstig met het kwaliteitsplan van het bedrijf te komen waar procesmanagement en informatiemanagement hand in hand gaan en waarbij de processen expliciet en transparant zijn. IMT-MS is momenteel geïmplementeerd in meerdere projecten in de tender fase en de implementatie van dit systeem wordt bij dit onderzoek gezien als case studie.

Resultaten en discussie
Een enquête is uitgevoerd onder gebruikers van IMT-MS; deze enquête is gebaseerd op de succesfactoren gedefinieerd in het literatuuronderzoek. De vragen van de enquête zijn onderverdeeld in zes verschillende onderwerpen; Persoonlijke informatie, Ontwikkeling, Communicatie, Mogelijkheden en Gebruiksgemak. De resultaten van de enquête zijn verder bediscussieerd tijdens vijf interviews met de managers en ontwikkelaars van IMT-MS: de directeur en afdelingshoofden. In de interviews zijn de belangrijkste succesfactoren aan bod gekomen en onderwerpen die niet aan bod konden komen tijdens de enquête met gebruikers van het systeem.
In de discussie worden de resultaten van de enquête en interviews verder besproken om tot een duidelijke en consistente interpretatie van de resultaten te komen. De discussie is verder besproken in de conclusie.

**Implementatieplan - organisatieniveau**
Het implementatieplan is gestructureerd in twee onderdelen; implementatie op organisatieniveau en implementatie op projectniveau. Het implementatieplan is geschreven voor een aannemer die wil beginnen met een gecombineerd IMS met KMS. Dit is verder uitgelegd in Figure 3; de afwegingen moeten eerst genomen worden om te beginnen met de ontwikkeling. Na de ontwikkeling is het besloten worden of het systeem voldoende ontwikkeld is om over te gaan op de implementatiefase of dat het systeem verder ontwikkeld moet worden. Na de implementatiefase wordt gekeken of de implementatie een succes is of niet; zo niet, moet het systeem verder ontwikkeld worden.

**Implementatieplan – projectniveau**
Op projectniveau moet er eerst beslist worden of (met de afwegingen in het achterhoofd) het project geschikt is voor het systeem. Vervolgens moet er beslist worden in welke fase de implementatie moet beginnen in het project; de tenderfase of realisatiefase. Na het project moet het werken met het systeem geëvalueerd worden.
Voor de implementatie van het systeem moeten de volgende afwegingen genomen worden om te overwegen of het project geschikt is voor het systeem; uniekheid van het project, het bedrijfsaandeel in het project, kennis van de (project)medewerkers, hoeveelheid disciplines betrokken en de contractvorm.

Na de beslissing of het systeem gebruikt zal worden voor het project zijn de volgende succesfactoren van belang tijdens de implementatie:

- Het doel moet duidelijk bekend gemaakt worden onder het projectteam; inclusief de medewerkers van het bedrijf, maar ook medewerkers van combinanten.
- De projectmanagers en afdelingshoofden spelen een cruciale rol in het implementatietraject; zij dienen actief de eindgebruiker te motiveren en de visie van de directie aangaand het systeem te ‘vertalen’ naar de eindgebruiker.
- Een verschillende uitleg dient gegeven te worden wanneer het systeem geïmplementeerd wordt in de tenderfase of realisatiefase; met de tenderfase moet de nadruk liggen op het structureren van eisen, met de realisatiefase op het bereiken van voldoende detail en op andere processen die gebruikt worden tijdens de realisatiefase.
- Na de eerste uitleg is intensieve ondersteuning nodig.

Conclusies
De conclusies zijn voornamelijk gebaseerd op de resultaten, discussie en het implementatieplan.

- Het doel van het ontwikkelde systeem is zeer belangrijk voor de ontwikkeling en implementatie. Het doel dient duidelijk bekend gemaakt te worden in het bedrijf en de projecten.
- De invloed van de directie, afdelingshoofden en directe leidinggevenden is belangrijk voor de implementatie; deze dienen de eindgebruiker te motiveren.
- De belangrijkste punten die uitgelegd dienen te worden tijdens een eerste uitleg zijn:
  o Het doel van het systeem
  o De processen van het Kwaliteit Management Systeem van het bedrijf
  o Uitleg hoe het systeem is gestructureerd
- De primaire functies moeten eerst voldoende ontwikkeld en geïmplementeerd zijn voordat secundaire functies geïntegreerd dienen te worden.
- Dit geldt ook voor de betrokkenheid van klanten, onderaannemers en leveranciers; deze dienen pas in het systeem betrokken te worden als het voldoende werkt in het bedrijf en projecten zelf.

Aanbevelingen

- De onderzoeksmethode inclusief Succesfactoren kan als basis dienen voor verder onderzoek naar dit onderwerp of voor implementatie van andere systemen.
- Onderzoek naar hoe andere industrieën met dit onderwerp omgaan kan nuttig zijn. Het kan ook nuttig zijn om te kijken of het nuttig is voor andere industrieën of een systeem als IMT-MS gebruikt kan worden.
- De integratie van BIM (Building Information Modelling) kan nuttig zijn voor het systeem.

Increase Quality through Information Management
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>As-Built drawings</td>
</tr>
<tr>
<td>AEC</td>
<td>Architecture, Engineering and Construction industry</td>
</tr>
<tr>
<td>BIM</td>
<td>Building Information Modelling</td>
</tr>
<tr>
<td>BVP</td>
<td>Best Value Procurement</td>
</tr>
<tr>
<td>DD</td>
<td>Definitive Design (Definitief ontwerp)</td>
</tr>
<tr>
<td>DMS</td>
<td>Document Management System</td>
</tr>
<tr>
<td>ED</td>
<td>Execution Design (Uitvoeringsontwerp)</td>
</tr>
<tr>
<td>EDMS</td>
<td>Electronic Document Management System</td>
</tr>
<tr>
<td>EMVI</td>
<td>Economisch Meest Voordelige Inschrijving (Economical Most Beneficial Offer)</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resources</td>
</tr>
<tr>
<td>HSE</td>
<td>Health, Safety and Environment</td>
</tr>
<tr>
<td>IMS</td>
<td>Information Management System</td>
</tr>
<tr>
<td>IMS-QMS</td>
<td>Information Management System integrated with the processes of the Quality Management System</td>
</tr>
<tr>
<td>IMT</td>
<td>Information Management Tool</td>
</tr>
<tr>
<td>IMT-MS</td>
<td>Information Management Tool with Management System</td>
</tr>
<tr>
<td>IPM</td>
<td>Integral Product Model</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>OD</td>
<td>Offer Design (Aanbiedingsontwerp)</td>
</tr>
<tr>
<td>PDI</td>
<td>Product Data Interchange</td>
</tr>
<tr>
<td>PDM</td>
<td>Product Data Management or Product Data Model</td>
</tr>
<tr>
<td>PIM</td>
<td>Project Information Management System</td>
</tr>
<tr>
<td>PLM</td>
<td>Product Lifecycle Management (EDM → PDM → PLM)</td>
</tr>
<tr>
<td>PR</td>
<td>Public Relations</td>
</tr>
<tr>
<td>QMS</td>
<td>Quality Management System</td>
</tr>
<tr>
<td>QIM</td>
<td>Quality and Information Management</td>
</tr>
<tr>
<td>RAW</td>
<td>Rationalisering Automatisering Water- en wegenbouw</td>
</tr>
<tr>
<td>SD</td>
<td>Structure Design (Structuurontwerp)</td>
</tr>
<tr>
<td>SE</td>
<td>Systems Engineering</td>
</tr>
<tr>
<td>SF</td>
<td>Success Factor</td>
</tr>
<tr>
<td>SMART</td>
<td>Specific Measurable Acceptable Realistic Time-bound</td>
</tr>
<tr>
<td>TD</td>
<td>Temporary Design (Voorlopig ontwerp)</td>
</tr>
<tr>
<td>UAV</td>
<td>Uniforme Administratieve Voorwaarden (Uniform Administrative Conditions)</td>
</tr>
<tr>
<td>UAV-gc</td>
<td>Uniforme Administratieve Voorwaarden voor geïntegreerde contractvormen (Uniform Administrative Conditions for integrated contract forms)</td>
</tr>
<tr>
<td>VS</td>
<td>Vraag Specificatie (Requirement Specification)</td>
</tr>
</tbody>
</table>
# Table of Contents

Colophon .......................................................................................................................... iii
Preface ................................................................................................................................ v
Summary ............................................................................................................................. vii
Samenvatting ................................................................................................................... xi
Abbreviations .................................................................................................................... xv
Table of Contents ............................................................................................................. xvii

1. Introduction .................................................................................................................... 1

2. Thesis structure............................................................................................................. 3
   2.1. Problem definition ................................................................................................. 3
   2.2. Objective ............................................................................................................... 3
   2.3. Scope of study ....................................................................................................... 3
   2.4. Research question ................................................................................................. 4
   2.5. Research approach ............................................................................................... 4

3. Literature study ............................................................................................................. 7
   3.1. Introduction .......................................................................................................... 7
   3.2. Quality management in construction industry ..................................................... 7
      3.2.1. Quality management systems ....................................................................... 8
   3.3. Information management in construction industry ............................................. 9
      3.3.1. Information management systems ............................................................... 10
   3.4. Differences tender and realisation phase ............................................................ 12
   3.5. Definition of success factors .............................................................................. 13
   3.6. Implementation theories ..................................................................................... 15
   3.7. Interim conclusion ................................................................................................. 17

4. Information Management and Quality Management Mobilis ....................................... 19
   4.1. Introduction .......................................................................................................... 19
   4.2. Introduction Mobilis ............................................................................................. 19
   4.3. Contract forms ..................................................................................................... 19
   4.4. Quality management Mobilis .............................................................................. 21
   4.5. Information management Mobilis ...................................................................... 22
   4.6. IMT-MS ................................................................................................................. 23
   4.7. Interim conclusion ................................................................................................. 24

5. Results ......................................................................................................................... 27
   5.1. Introduction .......................................................................................................... 27
   5.2. Survey .................................................................................................................. 27
   5.3. Survey results ....................................................................................................... 31
   5.4. Interviews ............................................................................................................ 43
1. Introduction

In previous times designs and calculations of infrastructure projects could be kept simple and most of the design work was done by public parties. With new contract forms like Design-Build-Finance-Maintain-Operate (DBFMO) or Public-Private Partnership (PPP) the responsibility of the complete project lies more and more with the private parties like contractors. The client wants to be unburdened and wants to utilize the market, with consequences for the contractor.

The contractors have to adapt to this policy change of mainly the Dutch government (Rijkswaterstaat, ProRail, provinces, etc.). The complexity of these projects leads to relatively high failure costs; about 8 to 10% of the total turnover of the construction sector, which is five to six billion euros per year (Brokelman, 2005). To decrease these costs the construction sector has to improve their processes and activities.

A contractor has five different ‘control factors’ to manage a construction project: Money, Organisation, Quality, Information and Time (Baars, 2006). This thesis is focused on the two factors Quality and Information and the integration of these two factors. The quality of a construction project means that the project must fulfil a number of quality requirements. The information factor is about the information necessary to fulfil a project and to have the information available for the right person. The goal with focusing on these two factors is to improve the processes of the construction sector and create synergy between the two factors.

Many articles are written about the two subjects ‘Information’ and ‘Quality’ in the construction industry separately, but there is not much information available about the integration of these two subjects (Cunha and Figueredo, 2005). Especially not specifically in the construction sector. While today the combination of the two factors is possible with current technologies and software. Another goal of this thesis is to fill this knowledge gap.

Mobilis

Mobilis B.V., a Dutch contractor specialized in concrete infrastructure, has developed an Information Management Tool including Management System (IMT-MS) which combines the information and quality factors in a software tool. This IMT-MS is developed for the information and quality management in projects and is currently implemented in several projects in the tender phase. This thesis was carried out at Mobilis B.V. and describes the information and quality management of the company, evaluates the implementation of IMT-MS in the tender phase and defines a plan to implement IMT-MS further in the company.

Reading guide

The first chapter after the introduction is the thesis structure (Chapter 2) including the problem definition, objective, scope of study, research question and research approach. Afterwards the literature study (chapter 3) includes Quality management and Information management in the construction industry, differences in the tender and realisation phase, the definition of success factors for the implementation of a combined Information management and Quality management system and implementation theories. Chapter 4 is about Mobilis and the literature applied on Mobilis; the contract forms of Mobilis are discussed, the Quality management and Information management of Mobilis and the combined system; IMT-MS. In the chapter Results (chapter 5) the survey and interviews are presented including the results. These results are combined and discusses in chapter 6 (Discussion). Eventually, the results and literature are combined in the implementation plan (chapter 7). The implementation plan is split up in organisation level and project level. At last the conclusions and recommendations are presented.
2. Thesis structure
This chapter clarifies the research and the steps that will be undertaken in this thesis. The thesis structure consists of the problem, the objective of the research, the research question with sub questions and the research approach.

2.1. Problem definition
The construction process is becoming more and more multidisciplinary with a large team of actors including the client, architect, engineers, designers, contractors and consultants. These team members often specialize in their discipline, but they are dependent on the other team members for their information. To improve the efficiency of this team, the information should be easily available for every team member.

The size and complexity of construction projects increases and therewith also the amount of information that will be produced and has to be processed. During a large scale project thousands of documents has to be processed. Therefore the management of the information is identified as an essential part of project management in the construction industry and is also one of the five project management factors (Money, Organisation, Quality, Information and Time) (Baars, 2006).

Another important factor of project management is quality. Multiple definitions of quality are available, but a practical definition applicable on the construction sector is “fitness to purpose” (Chau, 1991). The ‘purpose’ in the construction industry are the client’s requirements that have to be met. The main quality aspect in the construction sector is to meet the client’s requirements. Therefore, the client bears the responsibility of the requirements; the contractor bears the responsibility to meet those requirements.

With the size and complexity increasing in construction projects, the difficulty of verifying the requirements and therewith the verifying of the quality of the project increases. The overview is important with the verification of the quality, which is difficult to retain with a large project. The transferal of a project between different phases of the project is important to retain the overview and should also be checked on quality.

Together, these steps make the quality an important factor and needs certain processes to follow to maintain sufficient quality. The information flows are very important to ensure the quality of a project; therefore it is useful to integrate these two factors, but it’s difficult to thoroughly execute this. Lots of literature is written about the two factors separately, but not much is written about the combination of the two factors or the implementation of a QMS in an IMS. Therefore there is a knowledge gap, especially on this subject in the construction industry.

2.2. Objective
The primary objective that is defined:

“The research objective is to describe the experiences of users of a new information management and quality management system during the tender phase and to design an implementation plan for this system for a contractor at organisation level and tender and realisation project level.”

2.3. Scope of study
The demarcation of the research:

- The research will aim on the implementation of a combined QMS with IMS.
- The software and software development behind IMT-MS will be left out of consideration.
- The research will focus on the tender phase, because the new Quality and Information Management (QIM) is implemented in projects in the tender phase. The experiences from the tender phase can be used for the implementation plan for the realisation phase.
- The research is based on the current situation in the construction industry.
The research is based on the current situation according to IT developments.
The primary phase is considered the acquisition, selection, tender and realisation phase of a contractor.
The research on IMT-MS at Mobilis is considered a case study for this research.

2.4. Research question

The main research question:

“How to efficiently implement an Information Management System integrated with the processes of the Quality Management System within a contractor and its projects?”

To clarify and structure the research the following sub research question are defined:

Literature study

- What are the most relevant theoretical views on Quality Management, Information Management, Implementation and the success factors for implementation of quality management and information management systems?

Information and Quality management Mobilis

- What are the contract forms used and how is the Quality Management and Information Management structured at Mobilis?

Results

- What are the experiences of the users with IMT-MS during the tender phase, what are the considerations of the developers and managers regarding these experiences and what is the vision on the implementation process?

Discussion

- What is a clear and consistent interpretation of the results?

Implementation plan

- What is an effective set of considerations to decide on applying IMT-MS and further recommendations on developing and implementing this system on organisation and project level?

2.5. Research approach

The research approach is summarized in Figure 5. In Chapter 3, the literature study, the basis for the research is set. The literature study consists of literature about: Quality management, Information management, the differences of the tender and realisation phase, implementation theories and success factors for the implementation of a quality management system and an information management system.

The literature about quality management and information management is further used in chapter 4 (Information and Quality management Mobilis) to describe the information and quality management of Mobilis B.V. In this chapter the contract forms used by Mobilis B.V. are also described.

With the success factors defined in chapter 3.5 a survey has been developed which is sent to users and managers of the combined quality and information management system (IMT-MS). The results of this survey are also summed up in chapter 5. The success factors and the results of the survey are used to conduct five
interviews with the management and developers of Mobilis. The results of the interviews are summarized in chapter 5.

The results of the survey and interviews are further discussed in chapter 6.

The results of the survey and interviews, the literature, the quality and information management of Mobilis and the contract forms are further used to come to an implementation plan on organisation level and on project level for the tender and realisation phase in chapter 7. These two implementation plans are the main result of the conducted research.

Finally, the conclusion will be drawn based on the main research question in chapter 8 and recommendations in general, for Mobilis and for further research on this subject will be given in chapter 9.

Figure 5: Research approach
3. Literature study

3.1. Introduction

To create a solid base for the research, a literature study has been undertaken. The main research question of this chapter is:

- *What are the most relevant theoretical views on Quality Management, Information Management, Implementation and the success factors for implementation of quality management and information management systems?*

The chapter is split up in:

- **Quality management**
  An introduction and explanation of quality management in the construction industry and a brief introduction of different quality management systems.

- **Information management**
  An introduction of information management in the construction industry and a short summary of the different information management systems available on the market for project management in the civil engineering sector.

- **Differences tender and realisation phase**
  To come to a better understanding of the different phases in a contractor, the differences between the two main phases of a contractor will be appointed which can be used in the implementation plans.

- **Definition of success factors**
  From articles about the implementation of Information Management Systems (from Web-based Project Management Systems until general ICT systems) and Quality Management Systems (different QMS’s like ISO9001, Lean, Six Sigma, etc.) success factors will be derived for the implementation of a combined Quality Management System and Information Management System.

- **Implementation theories**
  Several theories for the implementation of ICT systems and general implementation theories are analysed as a basis for the implementation plan.

The sub research questions that will be questioned in this chapter and tried to be answered in the interim conclusion of the literature study:

- *Which quality management systems are available on the market and what are the advantages and disadvantages of these systems?*
- *Which information management systems are available on the market and what are the advantages and disadvantages of these systems?*
- *What are the essential differences between the tender and realisation phase for a contractor?*
- *What are the success factors for implementation of information management and quality management in a company?*
- *Which theories for implementation of a new Project Management System or ICT system are available?*

3.2. Quality management in construction industry

“*The main goal of the construction industry is to ensure that projects are successfully completed within the constraints of best quality, stated period and at minimum cost possible*” (Alaudin and Hassan, 2011). Therefore clients in the Architecture, Engineering and Construction (AEC) industry have high demands for the quality of the construction and the construction process. To guarantee the quality of a construction, different quality management methods are used to ensure the quality of buildings (Steens et al., 1998).
The origin of quality management can be explained from history; from 1900 until 1950 the engineers and architects were in total control during the design phase. In the construction phase they acted as supervisors to ensure the quality the owner requested was met. In the 1950’s and 1960’s the owners became more concerned at the cost and schedule factors, because the professionals were lacking on these factors. In that time the sealed competitive bid arose in the construction sector, giving the owner more possibility for advantageous pricing and the contractor to look to every advantage during construction to control cost and schedule. Also during that time mechanical and electrical systems became too complex for a general contractor to control, which leaded to subcontracting and sub-subcontracting. With these subcontracts, the quality control was delegated to the subcontractor. This leaded in the 1980’s to construction management firms that didn’t construct, but only managed the construction project. They emphasized on the quality control and a project quality control plan, because before the requirements on this topic were scattered throughout the contract. This leaded to procedures for inspecting and testing and procedures for the design process. These processes eventually became the Quality Management Systems. (Arditi and Gunaydin, 1997).

The definition of a Quality Management System (QMS) that is used for this thesis is: “A system by which an organisation aims to reduce and eventually eliminate non-conformance to specifications, standards, and customer expectations in the most cost effective manner.” (Business Dictionary, 2013) This ‘system’ in this thesis are the processes defined by the organisation, varying from the main processes in the company (acquisition and realisation of a construction) until the details in a company. To control these processes, the processes are constantly improved and updated to the current times and there is constantly checked if the defined processes are abided.

To achieve the level of quality requested by a client the production process has to be assured or the product quality has to be tested. The major goal of controlling the production process is to achieve more certainty about reaching the requested product quality. This can be reached by effectiveness, efficiency and balance. Effectiveness means that the set goals have to be reached, efficiency means that the project has to be executed as efficient as possible and balance means that the interests of the stakeholders have to be respected (Steens et al., 1998).

### 3.2.1. Quality management systems

Which quality management systems are available on the market and what are the advantages and disadvantages of these systems?

In the Netherlands, the most used Quality Management System (QMS) certification is based on the ISO 9000 series. Most of the contractors, suppliers and advising companies are certified, because most clients demand this during the tender phase. The ISO 9001 certification does not ensure that every construction project is successful, but it helps by defining the company processes in a management system (Steens et al., 1998). The ISO 9001 is generic, which in this case means that it can be applied on every kind of company; not only the construction industry. (Carlebur, 2007).
The major requirement for ISO 9001 certification is that the company has to develop a QMS, implement this in the company and continuous improvement of this QMS (ICS, 2008b). The improvement is summarised in the Plan-Do-Check-Act (PDCA) cycle of Deming, visualised in Figure 6. ‘Plan’ means to plan the activity beforehand, ‘Do’ to execute this activity according to the plan, ‘Check’ to check if the result is sufficient and ‘Act’ if measures have to be taken to reach the expected result or to prevent mistakes in the future. The PDCA cycle can be applied on different levels; from activity to complete project or company process. (Steens et al., 1998)

**Figure 6: Deming’s PDCA cycle**

Other quality management systems are also available, although they are less used in the Dutch construction industry, therefore only the definition is given:

- **Total Quality Management (TQM):**
  “TQM is an integrative philosophy of management for continuously improving the quality of products and processes” (Ahire, 1997).

- **Business Process Re-Engineering (BPR):**
  “The fundamental rethinking and radical redesign of business process to achieve dramatic improvement in critical contemporary measures of performance, such as cost, quality, service and speed” (Habib, 2013).

- **Lean manufacturing:**
  “The core idea is to maximize customer value while minimizing waste.” (Lean Enterprise Institute, 2009) Furthermore, there is no agreed upon definition of lean, because lean is constantly evolving. (Pettersen, 2009).

- **Six sigma:**
  “Six sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes” (Antony, 2008).

### 3.3. Information management in construction industry

An information management system for a contractor is mainly a “centralised information system that is accessible to all parties in a construction project.” (Scott et al., 2012). Currently, information systems are almost all electronically and the amount of web-based information systems are increasing. The internet is a useful medium for the exchange of information for construction projects, because of the often large size of the projects, the amount of stakeholders and the location of the projects (Scott et al., 2012).

An information management system is a central data facility that can be used to create and maintain goals, schedules, standards, policies, procedures, etc. Common features of such a system are (Scott et al., 2012):
Access to project information is accessible anywhere and at any time (often through internet).

Team communication, collaboration and decision-making is improved through the increased transparency in the management process.

Handling data is cost effective and not prone to errors and delays caused in duplication.

Project management is controlled and systematic. Updated information on progress is available to all and is shared as soon as possible.

The quality of the project data is high and meets the real needs of the professionals involved, as a result of the timely transmission of information between designated parties, use of specified task specific formats, data accuracy and backup in well-defined and powerful database repository.

Data of past projects is available for retrieval for new applications; for project maintenance needs, project planning, etc.

The information management in the construction industry went through three stages: the first stage was until the 1970s; products were directly used to improve efficiency by manual processes of information manipulation at operational level. The second stage was the development of stand-alone packages from 1970. The third stage, from 1990, was the development of stand-alone systems into strategic electronic platforms for real-time structured data exchange. These information systems hold, manage and use data for a variety of management functions; the internet is an ideal medium for this goal.

Another certification for construction companies is the ISO 15288, which is a Systems Engineering (SE) standard. SE is not an information management system, but it influences the information management in contractors, because the method is often used to structure the information during construction projects. The definition of INCOSE (International Council on Systems Engineering), which is also used by Rijkswaterstaat (RWS) of Systems Engineering is: “An interdisciplinary approach and means to enable the realisation of successful systems. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.” Systems Engineering is advised to be used by Rijkswaterstaat and ProRail, which are the major clients in the Civil Engineering industry in the Netherlands. It is currently not mandatory for contractors to be certified for the ISO 15288, but it is sometimes required for a construction project (RWS and ProRail, 2009).

3.3.1. Information management systems

Which information management systems are available on the market and what are the advantages and disadvantages of these systems?

Different Information Management Systems (IMS) are described and compared at certain aspects. The variety of the IMSs is broad and they focus on different aspects of a company or project.

Electronic Document Management System (EDMS)

The Electronic Document Management System (EDMS) is the simplest version of the discussed Information Management Systems. The definition of Electronic Document Management of CIMdata:

“Electronic Document Management (EDM) is the management of electronic documents and the processes used to create, release and maintain those documents within an enterprise. Most EDM systems can also manage paper based documents by reference to the physical location of the ‘paper’ document” (www.cimdata.com).

Two types of data are stored in an EDM system (Leenen, 2002):

- Product Data generated by various applications, such as specifications and CAD models.
- Meta-data, which is data about controlled product data. Meta-data is stored in a database and supports the functions performed by the core functionality.
Increase Quality through Information Management

An EDM system provides the following functions (Leenen, 2002):

- Central document storage
- Document retrieval and searching
- Document viewing, editing and printing
- Document version and status control
- Document authorisation

**Enterprise Resource Planning (ERP)**

Enterprise Resource Planning (ERP) is a system to integrate different processes inside a company or project. It started as a system for administration, but it grew to integrate multiple departments and it differs per company what is exactly integrated in the ERP.

A definition of Enterprise Resource Planning is “an integrated information technology solution, to better integrate various business functions and resources, particularly those related to project accounting procedures and practices” (Chung, 2008).

**Product Lifecycle Management (PLM)**

For comparison of different Information Management Systems the two systems Product Data Interchange (PDI) and Integral Product Model (IPM) are included under the name Product Lifecycle Management (PLM). The reason for this is because the terms PDI and IPM are slightly out of date and PLM is currently more used. Furthermore, the three systems have that much similarities, that for this comparison it is more useful to include the three under one name. The definitions of PDI and IPM are:

“Product Data Interchange (PDI) involves all activities that are necessary for the definition, archiving, management, exchange and usage of product data by means of electronic media in a technical environment. The product data is stored in standardised documents or product models and covers the total lifecycle of a product” (Teeuw, 1994).

“An Integral Product Model (IPM) is an electronic replica of the product (building) in a computer system. It is a single, well managed source of information and contains all data required for designing, building and (possibly) maintaining the product” (Leenen, 2002).

The definition of PLM is:

“Product Lifecycle Management (PLM) is the business activity of managing, in the most effective way, a company’s products all the way across their lifecycles; from the very first idea for a product all the way through until it’s retired and disposed of.” (Saaksvuori, 2011)

PLM is more used for the lifecycle of products in industry instead of projects in the construction industry, but the system can also be used for the construction industry.

**Building Information Modelling (BIM)**

Building Information Modelling (BIM) is an innovation that is increasingly used in the AEC industry. This new technology improves the design process, the lifecycle management of the facility and the project team collaboration. BIM uses parametric designing creating one model consisting of the input of all disciplines and creates a unique information database for a project. (Eastman et al., 2011)

“Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for
decisions during its life-cycle; defined as existing from earliest conception to demolition.” (National BIM Standard – United States)

3.4. Differences tender and realisation phase

What are the essential differences between the tender and realisation phase for a contractor?

Because the eventual implementation plan for the Information Management System with integrated Quality Management System will be separated for the tender phase and the realisation phase the differences of these two phases will be appointed. These differences are further used in chapter 6, the implementation plan. At first, the processes of the tender and realisation phase are described according to the Quality Management System of Mobilis:

Tender phase

The tender phase follows after the acquisition and possibly selection phase. The acquisition phase is where the available projects on the market are selected by the organization. The selection phase is where a company or alliance has to prove that they are capable of executing the project by selection criteria defined by the client.

After the acquisition phase or selection phase the tender phase commences. A tender team is composed, the contract is analysed, an approach plan is made and risk analysis is executed; after the risk analysis there is a GO / NO GO moment. When there is a GO after this moment, the tender team is enlarged and the data and objects are structured. Variants for the design are made and elaborated to come to an Offer Design (OD). After comment on the OD the activities are planned, the work methods are decided and the organisation of the project is decided.

After the calculation there is another internal GO / NO GO moment to decide by the management board if the price will be offered to the client. After this moment a file is made to offer to the client. After decision of the client, the project will be awarded or not. When the project is awarded, the contract will be signed and there can be continued to the realisation phase. (Mobilis, 2012a)

Realisation phase

After the awarding of the project during the tender phase, the realisation phase can start. At first a realisation team is composed and the project is transferred from the tender team to the realisation team. The data is structured in more detail and research is undertaken in more detail. The Quality Management System is filled in with; project management, surroundings management, technical management, procurement management, project control and project support. Further risks are analysed and the specifications for the Temporary Design (TD) are made and the TD is executed. The TD is checked and the same steps are taken for the Definitive Design (DD); the same steps are undertaken for the Execution Design. With the design steps the design is taken further in detail.

Work methods are defined and there is applied for permits. A detailed planning is made and the execution is started. During the execution the project is controlled and tested. A delivery file is made after completion including the As-Built drawings, test results and requirement validation report. With the delivery of this delivery file the project will be completed and afterwards evaluated. (Mobilis, 2012b)

Differences

With the processes explained, there are a lot of coincidences with the two phases. Both phases contain design loops to go further into detail and both phases have the composition of a project team. But there are also differences, based on the Quality Management System of Mobilis (Mobilis, 2012a and 2012b) and the conducted interviews of paragraph 5.5:

- The biggest difference lies in the level of detail; in the realisation phase the design goes through five loops to come to further detail.
Specific elements can be kept out of the design in the tender phase, but in the realisation every detail has to be designed.

The financial control during the realisation phase is more strict.

The client will test if the requirements are met during the realisation phase, not during the tender phase.

The team is newly started at the tender phase, with the realisation phase there is a transfer of the project, but often a large part of the team goes from the tender team to the realisation team, to keep the knowledge obtained during the tender phase.

The design that has won during the tender phase has to be ‘frozen’ including all the data that has been agreed upon by signing the contract. With the realisation phase there will be started with this design.

3.5. Definition of success factors

What are the success factors for the implementation of information management and quality management in a company?

To define the success factors for the implementation of an integrated Quality Management System (QMS) in an Information Management System (IMS) different literature has been reviewed on different subjects. Direct literature about this subject was not available, therefore success factors are defined about the implementation of a IMS and QMS separately first. These are compared, along with the few articles available about systems that combined QMS and IMS, and this leads to success factors (SF) which can be used for both systems.

The sequence of the success factors is now presented with the SF’s about IMS’s specifically first, then QMS’s specifically and afterwards a combined IMS with QMS. The sequence is changed for later purposes with the survey, therefore the SF’s are in a different sequence in this chapter.

First of all, literature on the implementation of IMS’s is reviewed. IMS’s are in this case

- Information systems
- Web-based project management systems
- Web-based construction information management systems
- Product Data Interchange (PDI)
- Enterprise Resource Planning (ERP)

These systems represent different industries; some systems can be used in every market segment, some only in the construction industry. These systems also differ on the usability; some systems can only be used in one part of a company (for instance administration), others for a complete company. The success factors derived from these articles can be found in Appendix A. All these success factors leaded to the following list of success factors, specifically for IMS’s:

- SF19: Decision support (Kim (2003))
- SF20: Compatibility with other systems (Scott (2012), Chung (2008))
- SF21: System quality (DeLone (2003), Kim (2003))
- SF22: Flexibility of queries and reporting formats (Nitithamyong (2010))
- SF23: System possibilities
  - SF23a: Document management
  - SF23b: Planning
  - SF23c: Costs
  - SF23d: Administration
  - SF23e: Procurement
Next to the success factors about IMS, success factors for the implementation of Quality Management Systems (QMS) are also derived from multiple articles. The different QMS’s analysed are:

- ISO 9001
- Total Quality Management (TQM)
- Business Process Re-engineering (BPR)
- Lean manufacturing
- Six sigma

These systems are not all used in the construction industry, but the implementation success factors and experiences with the systems can prove useful for the construction industry. The success factors derived from the different articles can be found in Appendix B. The success factors specifically for the implementation of a QMS are:

- SF24: Process support
- SF26: Process mapping (Al-Mashari and Zairi (1999))

The goal of this chapter is to come to success factors for the implementation of an IMS with an integrated QMS. Further literature about combined QMS and IMS were analysed, but no success factors could be defined. Therefore, the success factors of QMS and IMS are compared to lead to success factors that can be used for a combined system. These success factors are separated in technical and organisational:

**Organisational success factors**

- SF1: Clear and open goals and policy (Salaheldin (2008), Habib (2013), Al-Mashari and Zairi (1999), Bakas et al. (2011))
- SF3: User involvement
- SF4: Presence of a ‘champion’ (Nitithamyong (2010))
- SF6: Computer experience of project team members (Nitithamyong (2010))
- SF7: Open and effective communication (Sharp et al. (2005), Habib (2013), Al-Mashari and Zairi (1999), Bakas et al. (2011), Coronado et al. (2002))
- SF8: Exchange of data by team members (Teeuw (1994))
- SF10: Assigning of responsibilities (Cunha and Figueiredo (2005))
Increase Quality through Information Management

- SF11: Support quality (DeLone (2003), Nitithamyong (2010), Scott (2012), Chung (2008))
  - SF11a: Quality of support service (Nitithamyong (2010))
  - SF11b: Knowledge of support provider in construction (Nitithamyong (2010))
- SF12: Project duration (Nitithamyong (2010))
- SF13: Customer involvement (Pheng and Teo (2004), Salaheldin (2008))
- SF14: Supplier involvement (Yusof and Aspinwall (1999), Pheng and Teo (2004), Salaheldin (2008))

Technical success factors

- SF15: Adequate alignment of IT infrastructure with QMS strategy (Salaheldin (2008), Habib (2013), Al-Mashari and Zairi (1999))
- SF16: Redesign of QMS processes for integration in IMS
  - SF17a: Availability and reliability of data connections and IMT-MS access (Nitithamyong (2010))
  - SF17b: Data security (Nitithamyong (2010))
- SF18: Ease of system use (Nitithamyong (2010), Scott (2012), Kim (2003))
  - SF18a: Interface satisfaction (Kim (2003))

These success factors are further used to create a survey in chapter 5.2.

3.6. Implementation theories

Which theories for implementation of a new Project Management System or ICT system are available?

Lots of theories are available for implementing a new system or product in general and there are several theories for implementing a new ICT system. Not every theory will be summarized, but two useful theories will be explained for implementing a new information management system or implementing a system in general.

Gartner’s Hype Cycle

Gartner’s hype cycle treats five phases of the introduction of a new product or system, the theory can be applied on a large variety of products or systems. The theory is visualised in Figure 7, the five different phases:

1. Technology trigger
   A new product or system is implemented.
2. Peak of inflated expectations
   Only limited information is available about the system, but the expectations are high and limitations are not discussed.
3. Trough of disillusionment
   There will be realised that the high expectations cannot be met. Still only limited information is available about the system and this information is mainly about the problems and limitations of the system.
4. Slope of enlightenment
   After previous phases a large part of supporters has pulled out of the system, but the group still active with the system is working on the real implementation.
5. Plateau of productivity
   In this phase the system is implemented, can be used and there is transparency about the possibilities of the system.
Figure 7: Gartner’s Hype Cycle (source: O’Leary, 2008)

This theory can be used to analyse in which phase the implementation of a new information management system is at a certain moment and how users think about the system.

**Innovation theory Rogers**

The innovation theory from Rogers aims on the users of a new technology. Five different groups are separated, see also Figure 8:

1. **Innovators**
   - The first people who want to develop or adapt to a new technology.
2. **Early adopters**
   - Small part of majority that want new products or want to adapt to new systems.
3. **Early majority**
   - The ‘mass’ that start using a new system or product; with this group the group reaches maturity.
4. **Late majority**
   - The group that adapts to a new technology if the majority already uses it; more than 50% of the total group uses the product or system.
5. **Laggards**
   - The last persons that will use the system; with this group the system is fully implemented.

Figure 8: Innovation theory Rogers (Source: Rogers, 1971)

With this theory it is possible to determine in which group the different developers, users or managers are located.
3.7. **Interim conclusion**

The literature study has been undertaken to answer the following research question:

- *What are the most relevant theoretical views on Quality Management, Information Management, Implementation and the success factors for implementation of quality management and information management systems?*

Because different topics are addressed within this research question, the topics are answered separately.

**Quality management**

The introduction of quality management in the construction industry started in the 1950’s and the improvement of quality management systems (QMS) is still continuing. The origin lies in the shift of responsibilities and the complexity of the construction projects. A QMS is nowadays necessary to ensure the quality of a construction.

The most relevant definition of a QMS is: “A system by which an organisation aims to reduce and eventually eliminate non-conformance to specifications, standards, and customer expectations in the most cost effective manner” (Business Dictionary, 2013). The system in this thesis consists of the processes defined by the organisation; these processes are improved with the Plan-Do-Check-Act method. A well renowned certification for QMS’s in the construction industry is the ISO9001, different QMS’s used are:

- Total Quality Management (TQM)
- Business Process Re-engineering (BPR)
- Lean manufacturing
- Six sigma

**Information management**

Information management in the current construction industry is necessary because of the complexity of construction projects. The definition of an information management system (IMS) for the construction industry is a “centralised information system that is accessible to all parties in a construction project” (Scott et al., 2012). The difficult thing is to have the right information available for the right person, because with large construction projects there is a very large amount of information available, which has to be structured and clear to be easily accessible. The internet is now often used as a medium for IMS’s in the construction industry, because of the easy accessibility. Systems Engineering is now often used to structure the information during a project; which makes the communication easier between client and contractor. Information management systems that are often used are:

- Electronic Document Management System (EDMS)
- Enterprise Resource Planning (ERP)
- Product Lifecycle Management (PLM)
- Building Information Modelling (BIM)

**Differences tender and realisation phase**

The biggest difference between the tender and realisation phase is the level of detail of design; the design in the realisation phase is far more detailed than in the tender phase. Furthermore, the financial pressure and control of the client is added in the realisation phase. Another difference is that certain processes are added during the realisation phase, like testing and delivery. It is useful for the consistency of the project that key players of the tender project team are transferred to the realisation project team, because not all of the information can be transferred.

**Definition of success factors**

From literature about the implementation of IMS’s and QMS’s success factors are defined about the implementation of these two systems separately. These SF’s are compared to come to SF’s for a combined
Increase Quality through Information Management

system. Eventually, 26 success factors are defined, where 5 are specifically for the implementation of a IMS, 3 are specifically for the implementation of a QMS and 18 are for the implementation of a combined QMS with IMS. The success factors for a combined system are split up in organisational and technical success factors. The list of success factors can be found in paragraph 3.5.

**Implementation theories**

Two theories are explained for the implementation of a new IT system; the Gartner’s Hype cycle and the Innovation theory of Rogers. Gartner’s hype cycle separates five stages of the introduction of a new system; Technology trigger, Peak of inflated expectations, trough of disillusionment, slope of enlightenment and the plateau of productivity. The innovation theory of Rogers defines five different groups of users for a new technology; innovators, early adaptors, early majority, late majority and laggards.
4. Information Management and Quality Management Mobilis

4.1. Introduction

This thesis research has been conducted at the company Mobilis; Mobilis developed an Information Management System with integrated Quality Management System (IMT-MS). At first, Mobilis will be explained and the contract forms that Mobilis executes. The quality management, information management and IMT-MS of Mobilis is explained. This will be done according to the following research question and sub research question:

- What are the contract forms used and how is the Quality Management and Information Management structured at Mobilis?

Sub research questions:

- What are the current contract forms and demands from the different projects in the markets infrastructure, water and industry?

4.2. Introduction Mobilis

Mobilis is a Dutch contractor and part of TBI Infra (see Figure 9: Organisation chart TBI Holdings B.V.). TBI is a holding with 8,500 employees and an annual turnover of 2.2 billion euro. Mobilis, as part of TBI Holdings B.V., is a civil contractor specialised in the contracting and executing of projects in the civil construction industry in the Netherlands. Mobilis is active in the market segments Infrastructure, Water treatment and Industry and has an annual turnover of 185 million euros and has 240 employees (in 2011).

<table>
<thead>
<tr>
<th>TBI</th>
<th>Infra</th>
<th>Voorbij Funderingstechniek</th>
<th>Voorbij Prefab Beton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Techniek</td>
<td>Bouw &amp; Ontwikkeling</td>
<td>J.P. van Eesteren</td>
<td></td>
</tr>
<tr>
<td>Acto Informatiering</td>
<td>ERA Contour</td>
<td>Hasselberg Bouw</td>
<td></td>
</tr>
<tr>
<td>Atien</td>
<td>Revo</td>
<td>Koopmans Bouwgroep</td>
<td></td>
</tr>
<tr>
<td>Croon Elektrotechniek</td>
<td>MCB</td>
<td>Synchroon</td>
<td></td>
</tr>
<tr>
<td>Eskets Elektrotechniek</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RH-Jado</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVJ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingenieursbureau Weller &amp; Dros</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTH Vloerverwarming</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Organisation chart TBI Holdings B.V.

In July 2006 the three civil contractors Haverkort, Voormolen and Galjaard, all part of TBI Holdings B.V., merged to Haverkort Voormolen. The name changed to Mobilis in July 2009.

4.3. Contract forms

What are the current contract forms and demands from the different projects in the markets infrastructure, water and industry?

Currently lots of different contract forms are available in the construction industry. These contract forms mainly differ by the amount of responsibility the contractor is assigned to during the construction process. To organize the different contracts and responsibilities during a contract a standard scheme can be used to visualise the roles during a contract. The two schemes below (Figure 10 and Figure 11) can be used in almost every construction project to define the activities in phase or time and to define the participants in the project.
In Figure 10 the building process is visualised with the different phases of the project and participants. The blue (dark) bars in the figure are always the primary responsibility of the client itself. The client has to be able to define his project financially, economically and socially. In integral contracts the client is sometimes assisted by a consultant (for example an engineering company). If the consultant helps the client the consultant cannot be the contractor or have another role than consultant later in the project. The consultant often also helps the client during the selection and tender phase.

The conceptual design and the definition of the functional specification has to be made by the client. After the completion of this, the rest of the white bars in Figure 10 can be contracted on a commercial basis. Somewhere in the design process, between the program definition and the making of the work drawings, the transfer of responsibility takes place. This is the transfer of activities from consultants to contractor and industry. This moment defines the level of integration and the type of contract used for the realisation of the process (Roelofs and Reinderink, 2005).
Increase Quality through Information Management

![Diagram of basic building organisation scheme](Source: Roelofs and Reinderink, 2005)

Originally only two parties were involved during the construction process; the client and the contractor. During the last decades more parties were added; the financier and consultant. Also, the contractor is split up in project manager, design manager and the direction and supervision. This ‘basic’ organisation chart can be seen in Figure 11. Every party in this chart can accept responsibilities for these roles; the acceptance of these responsibilities defines the contract form.

To make the different contract forms more specific, contract forms can be distinguished in these five types:

- Traditional contracts
  Separated responsibilities and tendering on lowest price with detailed given quality level (in the Netherlands the RAW contracts).

- Mediated through third party
  A specific party had the responsibility of the coordination of tender- and realisation process.

- Integrated contracts
  Design and Build (D&B), Design and Construct (D&C), Turnkey, etc. with the execution of the project on basis of fixed price (in the Netherlands UAV-gc).

- Extra integrated contracts
  For example Design-Build-Operate (DBO) or concession contracts; the client remains owner of the project, but doesn’t operate it.

- Public-Private Partnership (PPP)
  A partnership between a Public (governmental) organisation and a Private organisation (company) for the purpose of completing a project that will serve the public.

### 4.4. Quality management Mobilis

During the period right after the merger of the three civil contractors Haverkort, Voormolen and Galjaard (July 2006) it was not completely clear which Quality Management System (QMS) was going to be used within the company and during projects. To structure the ‘new’ company and its projects Mobilis developed a new QMS, which contained the general business processes of the company, the project processes, the policy of Mobilis, standard documents, forms, etc. (see

This figure contains confidential information and is only available at Mobilis B.V., the concerned graduation committee members and the author. This figure is not included in the public version of the thesis.
The definition of quality from the policy statement: “To control the processes in an optimal way to come to product with high quality. Furthermore we aspire to meet the current and future requirements of our clients to minimize the avoidable costs, despite of the more complex projects and the bigger liability.” (Mobilis, 2012).

This figure contains confidential information and is only available at Mobilis B.V., the concerned graduation committee members and the author. This figure is not included in the public version of the thesis.

The QMS was erected with this goal.

The Quality Management System (QMS) of Mobilis (the frontpage can be seen in

This figure contains confidential information and is only available at Mobilis B.V., the concerned graduation committee members and the author. This figure is not included in the public version of the thesis.

Figure 12, in Dutch) consists of a description of the processes that are used at the company Mobilis. The input (on the left) is from the contract (of the project or client) and the output is from the contract and the QMS. The QMS is pyramid structured and consists of the levels ‘Policy’, ‘General company processes’ and ‘Primary processes’. The Policy is the company policy set by the board of directors. The General company processes are installed to structure the HR department, Communication, Document control, Sustainability, PR, Quality, HSE, etc.

The largest part of the QMS are the primary processes, which structure the projects (the main source of income of a contractor) and consists mainly of the Acquisition phase, Selection phase, Tender phase and Realisation phase. The Tender phase and Realisation phase are differentiated between traditional contracts and other contracts, because these contracts require different processes. The tender phase consists of the project start-up, design and offer. The realisation phase consists of the project start-up, design, preparation, execution and deliver. Furthermore, the primary processes are divided in five different parts; the Project management, Technical management, Surroundings management, Project control and Project support. This is further divided in detail processes.

All these processes are designed by the management board or the heads of the departments and put together by the Quality department of Mobilis. The function of the Quality department is facilitating, monitoring and reporting according to these processes and thereby advising the management board as well as the department heads. This is done by auditing different personnel according to the processes to ensure the quality of the company and the projects.
Increase Quality through Information Management

The Quality Management System (QMS) is currently integrated in IMT-MS, the Information Management Tool with integrated Management System, which will be explained further in paragraph 4.6. The goal on Quality Management level with IMT-MS is:

*To create process-wise quality improvement and have consistent steps between the first contact with the client and completion of projects. The company should be unified in working methods, but also in providing information to external parties.*

4.5. Information management Mobilis

Rijkswaterstaat started in 2007 with introducing the first ‘leidraad Systems Engineering’ to contractors in civil engineering. Mobilis also adapted to the Systems Engineering (SE) method by structuring information flows during projects.

**Systems Engineering**

Systems Engineering (SE) originates from the telephony sector during the second World War. In the Netherlands SE was the first time applied in 1998/99 for ProRail’s Northern Betuwe Route. After that SE became the standard methodology for integrated contracts. Systems Engineering is used for the following functions (Rijkswaterstaat, 2008):

- the structured specification of a requirement
- the structured design of a suitable solution to the requirement
- use of the proper approach to produce this solution
- use of the proper approach to manage the produced solution
- use of the proper verification and validation approach
- use of a controlled approach to manage the total system during its entire life cycle

**Microsoft Access**

Microsoft Access was first used to apply Systems Engineering during projects. Objects and requirements were structured, but not in a clear overview.

**Relatics**

Relatics is an information control tool that can control, share and relate information, based on Product Lifecycle Management. It gives a clear insight in the information that is available with a Systems Engineering background.

Mobilis decided to develop their own Information Management Tool (IMT) in the ‘empty hull’ Relatics. This first became an Information Management Tool without integrated Quality Management System. The first project in realisation phase with Relatics was the highway project A50 Ewijk-Valburg. With this project it proved to be efficient with the delivery of the project; the delivery files were easily processed.

With the decision to integrate the Quality Management System in this IMT the goal of information management in IMT-MS:

*To control and optimize the handling of the streams of information during projects and have one data storage facility which is accessible for everybody who needs the data. IMT-MS should become a platform of knowledge.*

4.6. IMT-MS

The QMS and introduction of the SE method resulted in the Information Management Tool (IMT-MS) that is currently being developed by Mobilis. IMT-MS facilitates and supports the projects and company organisation.
in structuring and managing of all information flows and contributes to a transparent and explicit process. IMT-MS enables to structure the large amount of requirements from projects with complex contract forms.

The goal of IMT-MS is:

*To realise successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent.*

**Relatics**

IMT-MS is like the version before, IMT, based on the Relatics tool. The former version is further processes and the Quality Management System is integrated in Relatics. IMT-MS links to the Document Management Tool Chapoo.

---

Figure 13: Homepage IMT-MS

*This figure contains confidential information and is only available at Mobilis B.V., the concerned graduation committee members and the author. This figure is not included in the public version of the thesis.*

Figure 12. Furthermore, the processes of the Management System are incorporated in IMT-MS to create an Information Management system that follows the processes defined in the Management System. An example of a process in IMT-MS is shown in

*This figure contains confidential information and is only available at Mobilis B.V., the concerned graduation committee members and the author. This figure is not included in the public version of the thesis.*
4.7. **Interim conclusion**

The contract forms that Mobilis executes and the information management, quality management and IMT-MS are explained to answer the research question:

- What are the contract forms used and how is the Quality Management and Information Management structured at Mobilis?

Because different topics are mentioned in this research question the topics are answered separately.

**Contract forms**

Lots of different contract forms are available in the construction industry and more contract forms keep coming. The contract forms mainly differ by the amount of responsibility of the contractor during the construction process. The main part for the contractor is always the construction, but this can be expanded with the design, defining technical specifications, financing, project management, operating and maintaining.

The contracts that are mostly executed by Mobilis are Design and Build or Design and construct.

**Quality management and information management Mobilis**

The Quality Management System (QMS) of Mobilis structured in a ‘pyramid’ way with the company policy on top. Below the policy are the company processes, primary processes, sub processes and forms, standard documents, etc. The processes are defined by the management board and the department heads. The quality department is facilitating, monitoring and reporting according to these processes and thereby advising the management board as well as the heads of department.

The information management is mainly based on the method Systems Engineering (SE); SE is “an interdisciplinary approach and means to enable the realisation of successful systems. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.” (RWS and ProRail, 2009). SE in the construction industry is used to structure the specifications and requirements, manage these during the projects and verificate and validate these after the project. Mobilis decided to develop their own Information Management Tool (IMT) in the software called Relatics.

The QMS and IMT are combined in the currently developed IMT-MS. In this system the layout of the QMS is used and the processes are integrated in the already existing IMT. The goal is to realise successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent.
Increase Quality through Information Management
5. Results

5.1. Introduction
The success factors described in chapter 3.5 will be used to develop a survey. With this survey the experiences of users can be described with an Information Management Tool with integrated Quality Management System.

After the survey, five interviews are conducted with managers and developers, partly based on the results of the survey.

The survey and interviews are conducted with the following research question in mind:

- What are the experiences of the users with IMT-MS during the tender phase, what are the considerations of the developers and managers regarding these experiences and what is the vision on the implementation process?

5.2. Survey
For the users and managers of IMT-MS, the Information Management System (IMS) with integrated Quality Management System (QMS) system of Mobilis, a survey is defined. This survey is based on the success factors defined in chapter Definition of success factors 3.5. These success factors matched with the questions of the survey can be found in Table 1. The complete survey, conducted online with Surveymonkey, can be found in Appendix C.

For almost every success factor there has formed a survey question for the user of IMT-MS. For three success factors it was not useful to question this to the user; SF4: Presence of a ‘champion’, SF13: Customer involvement and SF14: Supplier involvement. These success factors are discussed later with the interviews (See paragraph 0).

For the rest of the success factors the sequence is changed to come to a logical interview in different themes, as can be seen in Table 1. These themes are:

- Personal data
  The first page is about personal data to come to a better understanding of the users. The age, education, work experience, company, department, etc. of the user of IMT-MS is asked.

- Development IMT-MS:
  The experiences of the user concerning the organisational development until the moment of conducting the survey. The organisational development is about the goal and policy, the support of different management layers and the involvement of users in the development and implementation phase.

- Communication
  The experiences of the user with the communication of IMT-MS; the openness of communication, exchange of data, collaboration, responsibilities and support quality.

- Possibilities
  The experiences of the user with possibilities of IMT-MS; the influence of project duration, decision support, compatibility, system quality and system possibilities.

- Processes
  Because of the integration of the Quality Management System (QMS), the processes defined in the QMS play an important role. These questions are about these integrated processes; alignment of IT infrastructure with QMS, process support, process improvement, process mapping and redesign of processes for IMT-MS.
• **Ease of use**
  The experiences of users about the ease of use of IMT-MS; the reliability of the system, ease of use in general, interface satisfaction and clarity of the homepage.

As addition to the general questions based on success factors on every page (except personal data) there is asked what the importance is of the questions of this page according to success of IMT-MS. This leads to a ranking of importance of questions on every page according to the user. Also, at the end of every page there is room for comment.
## Table 1: Success factors with survey questions

<table>
<thead>
<tr>
<th>Success factors Information Management System with integrated Quality Management System:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organisational:</strong></td>
<td></td>
</tr>
<tr>
<td>SF1: Clear and open goals and policy (Salaheldin (2008), Habib (2013), Al-Mashari and Zairi (1999), Bakas et al. (2011))</td>
<td></td>
</tr>
<tr>
<td>SF3: User involvement</td>
<td></td>
</tr>
<tr>
<td>SF4: Presence of a ‘champion’ (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF5: Adequacy of training (Nitithamyong (2010), Sharp et al. (2005), Yusuf and Aspinwall (1999), Salaheldin (2008), Al-Mashari and Zairi (1999), Bakas et al. (2011), Coronado et al. (2002))</td>
<td></td>
</tr>
<tr>
<td>SF6: Computer experience of project team members (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF7: Open and effective communication (Sharp et al. (2005), Habib (2013), Al-Mashari and Zairi (1998), Bakas et al. (2011), Coronado et al. (2002))</td>
<td></td>
</tr>
<tr>
<td>SF8: Exchange of data by team members (Teeuw (1994))</td>
<td></td>
</tr>
<tr>
<td>SF10: Assigning of responsibilities (Cunha and Figueiredo (2005))</td>
<td></td>
</tr>
<tr>
<td>SF11: Support quality (Decone (2003), Nitithamyong (2010), Scott (2012), Chung (2008))</td>
<td></td>
</tr>
<tr>
<td>SF11a: Quality of support service (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF11b: Knowledge of support provider in construction (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF12: Project duration (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF13: Customer involvement (Pheng and Teo (2004), Salaheldin (2008))</td>
<td></td>
</tr>
<tr>
<td>SF14: Supplier involvement (Yusuf and Aspinwall (1999), Pheng and Teo (2004), Salaheldin (2008))</td>
<td></td>
</tr>
<tr>
<td><strong>Technical:</strong></td>
<td></td>
</tr>
<tr>
<td>SF15: Adequate alignment of IT infrastructure with QMS strategy (Salaheldin (2008), Habib (2013), Al-Mashari and Zairi (1999))</td>
<td></td>
</tr>
<tr>
<td>SF16: Redesign of QMS processes for integration in IMS</td>
<td></td>
</tr>
<tr>
<td>SF17a: Availability and reliability of data connections and IMT access (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF17b: Data security (Nitithamyong (2010))</td>
<td></td>
</tr>
<tr>
<td>SF18: Ease of system use (Nitithamyong (2010), Scott (2012), Kim (2003))</td>
<td></td>
</tr>
<tr>
<td>SF18a: Interface satisfaction (Kim (2003))</td>
<td></td>
</tr>
</tbody>
</table>

### Notes
- **Organisational:**
  - SF1: Clear and open goals and policy
  - SF2: Top management support
  - SF3: User involvement
  - SF4: Presence of a ‘champion’
  - SF5: Adequacy of training
  - SF6: Computer experience of project team members
  - SF7: Open and effective communication
  - SF8: Exchange of data by team members
  - SF9: Improvement of collaboration
  - SF10: Assigning of responsibilities
  - SF11: Support quality
    - SF11a: Quality of support service
    - SF11b: Knowledge of support provider in construction
  - SF12: Project duration
  - SF13: Customer involvement
  - SF14: Supplier involvement

- **Technical:**
  - SF15: Adequate alignment of IT infrastructure with QMS strategy
  - SF16: Redesign of QMS processes for integration in IMS
  - SF17: System reliability
    - SF17a: Availability and reliability of data connections and IMT access
    - SF17b: Data security
  - SF18: Ease of system use
    - SF18a: Interface satisfaction

### Questions
- **Organisational:**
  - SF1: Is the underlying policy of IMT-MS clear?
  - SF2: Is the goal of IMT-MS clear?
  - SF3: Do you experience enough motivation/support from the head of your department to use IMT-MS?
  - SF4: Do you experience enough motivation/support from your direct supervisor to use IMT-MS?
  - SF5: Is the end user sufficiently involved during the implementation process of IMT-MS?
  - SF6: Is the end user sufficiently involved during the development process of IMT-MS?
  - SF7: Is the end user sufficiently involved during the implementation process of IMT-MS?
  - SF8: Is the end user sufficiently involved during the development process of IMT-MS?
  - SF9: Is the end user sufficiently involved during the implementation process of IMT-MS?
  - SF10: Is the end user sufficiently involved during the development process of IMT-MS?

- **Technical:**
  - SF11: Is the goal of IMT-MS clear?
  - SF12: Is the underlying policy of IMT-MS clear?
## Increase Quality through Information Management

### Success factors Information Management System:

| SF19: Decision support (Kim (2003)) | 36. Does IMT-MS support the decision making during a project? |
| SF20: Compatibility with other systems (Scott (2012), Chung (2008)) | 37. Are there sufficient possibilities to store the decision making in IMT-MS and Chapoo? |
| SF21: System quality (DeLone (2003), Kim (2003)) | 38. Is the compatibility of IMT-MS with other software/programmes sufficient? |

#### SF20: Compatibility with other systems (Scott (2012), Chung (2008))

- Does IMT-MS support the decision making during a project?
- Are there sufficient possibilities to store the decision making in IMT-MS and Chapoo?

#### SF21: System quality (DeLone (2003), Kim (2003))

- Do IMT-MS and Chapoo offer sufficient possibilities on these fields:
  - Project management
  - Technical management
  - Surroundings management
  - Project control
  - Reporting

### Success factors Quality Management System:

| SF24: Process support | 46. Does IMT-MS support the processes of the Management System sufficiently? |
| SF25: Process improvement (Sharp et al. (2005), Yusof and Aspinwall (1999), Pheng and Teo (2004), Salaheldin (2008), Al-Mashari and Zairi (1999)) | 47. Does IMT-MS improve the usage of the processes used by Mobilis? |
| SF26: Process mapping (Al-Mashari and Zairi (1999)) | 48. Are the Management System' processes clearer because of IMT-MS? |

#### SF24: Process support

- Does IMT-MS support the processes of the Management System sufficiently?
5.3. **Survey results**

*What are the experiences of developers, users and managers with the current system?*

*What are the experiences of developers, users and managers with IMT-MS?*

The survey (as can be seen in Appendix C and summarized in paragraph 5.2) is sent to 86 users of IMT-MS of 8 different projects. These users work at different companies because of the alliances made during projects and other users are hired employees for the specific project. All of the projects are in the tender phase during the execution of the survey. In total 30 out of 86 users of IMT-MS completely filled in the survey and 5 users partly filled in the survey; the results of the partly filled in surveys are also processed.

The comprehensive results of the survey can be found in Appendix D. The results will be summed up shortly in this chapter.

**Personal data**

The page about personal data is used to come to a better understanding of the users. The age, education, work experience, company, department, etc. of the user of IMT-MS is asked.

Q1: What is your *age*?
The average age of the users of IMT-MS is 39.8 years; the youngest is 24 and the oldest 60.

Q2: What is your *highest level of education*?
5,71% MBO, 65,71% HBO and 28,57% WO.

Q3: How many *years of work experience* do you have?
The average amount of years of work experience is 16,8 with the shortest 0,5 years and the longest 35 years.

Q4: At which *company* do you work?
47,22% (17 people) of the users works at Mobilis, 11,11% (4 people) at Van Gelder and the rest works at different companies, mainly hired engineering companies.

Q5: How many *years do you work at this company*?
The average amount of years of work experience at the current company is 7,7 with the shortest 0,5 years and the longest 25 years.

Q6: On which *department* of the company do you work?
The most users work on the design department (28,57%, 10 people), the second on project preparation (17,14%, 6 people) and both 5 people (14,29%) on acquisition on others. The other departments are three or less.

Q7: On which *projects* did you use IMT-MS?
Of course most of the people used IMT-MS for the projects that are mentioned before, but also other (older) projects are raised.

Q8: Do you have a *leadership function* during projects?
31,43% (11 people) have a leadership function during projects, 68,57% (24 people) not.

**Development IMT-MS**

The experiences of the user concerning the organisational development until the moment of conducting the survey. The organisational development is about the goal and policy, the support of different management layers and the involvement of users in the development and implementation phase.
The absolute numbers in the tables below are the amount of users who checked this option; the other number is the percentage out of total (including ‘Not applicable’).

**SF1: Clear and open goals and policy**
Q10: Is the underlying policy of IMT-MS clear?
Q11: Is the goal of IMT-MS clear?

Table 2: Survey results: SF1 - Clear and open goals and policy

<table>
<thead>
<tr>
<th></th>
<th>Very unclear</th>
<th>Unclear</th>
<th>Clear</th>
<th>Very clear</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlying policy</td>
<td>0</td>
<td>0,00%</td>
<td>14</td>
<td>51,43%</td>
<td>18</td>
</tr>
<tr>
<td>Goal</td>
<td>0</td>
<td>0,00%</td>
<td>7</td>
<td>68,57%</td>
<td>24</td>
</tr>
</tbody>
</table>

**SF2: Top management support**
Q12: Do you experience enough motivation/support from the management board to use IMT-MS?
Q13: Do you experience enough motivation/support from the head of the department to use IMT-MS?
Q14: Do you experience enough motivation/support from your direct supervisor to use IMT-MS?
Q15: Do you experience enough motivation/support from your colleagues to use IMT-MS?

Table 3: Survey results: SF2 - Top management support

<table>
<thead>
<tr>
<th></th>
<th>No support</th>
<th>Little support</th>
<th>Sufficient support</th>
<th>Ample support</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management board</td>
<td>4</td>
<td>11,43%</td>
<td>14</td>
<td>22,86%</td>
<td>3</td>
</tr>
<tr>
<td>Department head</td>
<td>1</td>
<td>2,86%</td>
<td>10</td>
<td>22,86%</td>
<td>8</td>
</tr>
<tr>
<td>Direct supervisor</td>
<td>2</td>
<td>5,71%</td>
<td>10</td>
<td>20,00%</td>
<td>8</td>
</tr>
<tr>
<td>Colleagues</td>
<td>3</td>
<td>8,57%</td>
<td>9</td>
<td>51,43%</td>
<td>2</td>
</tr>
</tbody>
</table>

**SF3: User involvement development phase (SF3a) and implementation phase (SF3b)**
Q16: Is the end user sufficiently involved during the development process of IMT-MS?
Q17: Is the end user sufficiently involved during the implementation process of IMT-MS?

<table>
<thead>
<tr>
<th></th>
<th>No involvement</th>
<th>Little involvement</th>
<th>Sufficient involvement</th>
<th>Ample involvement</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>User involvement development</td>
<td>7</td>
<td>20,00%</td>
<td>15</td>
<td>42,86%</td>
<td>9</td>
</tr>
<tr>
<td>User involvement implementation process</td>
<td>7</td>
<td>20,00%</td>
<td>18</td>
<td>51,43%</td>
<td>6</td>
</tr>
</tbody>
</table>
SF5: Adequacy of training
Q18: Is the training/explanation that is provided sufficient to work well with IMT-MS?

<table>
<thead>
<tr>
<th>Training / explanation</th>
<th>No training</th>
<th>Training insufficient</th>
<th>Training sufficient</th>
<th>Training ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13</td>
<td>11</td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>37,14%</td>
<td>31,43%</td>
<td>22,86%</td>
<td>0,00%</td>
<td>8,57%</td>
</tr>
</tbody>
</table>

SF6: Computer experience of team members
Q19: Is the computer experience of colleagues within your project team sufficient to work with IMT-MS?

<table>
<thead>
<tr>
<th>Computer experience</th>
<th>No experience</th>
<th>Insufficient experience</th>
<th>Sufficient experience</th>
<th>Ample experience</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>19</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>5,71%</td>
<td>11,43%</td>
<td>54,29%</td>
<td>20,00%</td>
<td>8,57%</td>
</tr>
</tbody>
</table>

The question about importance of the questions leads to the ranking below. The top three is bold:

<table>
<thead>
<tr>
<th>SF1</th>
<th>Q10: Underlying policy</th>
<th>Score</th>
<th>SF1</th>
<th>Q11: Goal</th>
<th>Score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF2</td>
<td>Q12: Motivation from management board</td>
<td>3</td>
<td>SF2</td>
<td>Q13: Motivation from department head</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>SF2</td>
<td>Q14: Motivation from direct supervisor</td>
<td>41</td>
<td>SF2</td>
<td>Q15: Motivation from colleagues</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>SF3a</td>
<td>Q16: Involvement development process</td>
<td>-54</td>
<td>SF3b</td>
<td>Q17: Involvement implementation process</td>
<td>-43</td>
<td>8</td>
</tr>
<tr>
<td>SF5</td>
<td>Q18: Provided training</td>
<td>-20</td>
<td>SF6</td>
<td>Q19: Computer experience</td>
<td>-84</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Figure 15 all results of the page ‘Development IMT-MS’ are summarized; red means negative and green positive. The results are ordered by importance.
Communication
The experiences of the user with the communication of IMT-MS; the openness of communication, exchange of data, collaboration, responsibilities and support quality.

The absolute numbers in the tables below are the amount of users who checked this option; the other number is the percentage out of total (including ‘Not applicable’).

**SF7: Open and effective communication**
Q22: Do IMT-MS and Chapoo lead to open and effective communication?

<table>
<thead>
<tr>
<th></th>
<th>Not possible</th>
<th>Little open and effective</th>
<th>Reasonable open and effective</th>
<th>Very open and effective</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>1</td>
<td>2,94%</td>
<td>15</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**SF8: Exchange of data by team members**
Q23: Do IMT-MS and Chapoo promote the exchange of information between project team members?

**SF9: Improvement of collaboration**
Q24: Does IMT-MS have effect on the collaboration within a project?

<table>
<thead>
<tr>
<th></th>
<th>Not possible</th>
<th>Deteriorates</th>
<th>Does not change</th>
<th>Improves</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data exchange</td>
<td>1</td>
<td>2,94%</td>
<td>4</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Collaboration</td>
<td>0</td>
<td>0,00%</td>
<td>5</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

**SF10: Assigning of responsibilities**
Q25: Are the roles and permissions clearly assigned within IMT-MS?
Increase Quality through Information Management

<table>
<thead>
<tr>
<th>Role and permissions</th>
<th>Very unclear</th>
<th>Unclear</th>
<th>Clear</th>
<th>Very clear</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>19</td>
<td>10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>8,82%</td>
<td>55,88%</td>
<td>29,41%</td>
<td>2,94%</td>
<td>2,94%</td>
</tr>
</tbody>
</table>

**SF11a: Quality of support service**
Q26: Is the support for IMT-MS from the Building Process (BP) department sufficient?
Q27: Is the support for IMT-MS from the Quality department sufficient?

**SF11b: Knowledge of support provider in construction**
Q28: Has the Building Process department sufficient affinity with the construction industry to provide support for IMT-MS?
Q29: Has the Quality department sufficient affinity with the construction industry to provide support for IMT-MS?

<table>
<thead>
<tr>
<th>Support BP</th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,94%</td>
<td>5</td>
<td>20</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14,71%</td>
<td>58,82%</td>
<td>0</td>
<td>23,53%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Support Quality</th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>8,82%</td>
<td>6</td>
<td>14</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17,65%</td>
<td>41,18%</td>
<td>5,88%</td>
<td>26,47%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge BP</th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,94%</td>
<td>5</td>
<td>17</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14,71%</td>
<td>50,00%</td>
<td>2,94%</td>
<td>29,41%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge Quality</th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5,88%</td>
<td>6</td>
<td>13</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17,65%</td>
<td>38,24%</td>
<td>2,94%</td>
<td>35,29%</td>
</tr>
</tbody>
</table>

The question about importance of the questions leads to the ranking below. The top three is bold:

<table>
<thead>
<tr>
<th>SF7</th>
<th>Q22: Open and effective communication</th>
<th>Score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF8</td>
<td>Q23: Exchange of information</td>
<td>88</td>
<td>1</td>
</tr>
<tr>
<td>SF9</td>
<td>Q24: Collaboration within project</td>
<td>61</td>
<td>3</td>
</tr>
<tr>
<td>SF10</td>
<td>Q25: Clearness roles and permissions</td>
<td>-9</td>
<td>4/5</td>
</tr>
<tr>
<td>SF11a</td>
<td>Q26: Support Building Process department</td>
<td>-9</td>
<td>4/5</td>
</tr>
<tr>
<td>SF11a</td>
<td>Q27: Support Quality department</td>
<td>-48</td>
<td>6</td>
</tr>
<tr>
<td>SF11b</td>
<td>Q28: Affinity construction industry BP department</td>
<td>-56</td>
<td>7</td>
</tr>
<tr>
<td>SF11b</td>
<td>Q29: Affinity construction industry Quality department</td>
<td>-96</td>
<td>8</td>
</tr>
</tbody>
</table>

In Figure 16 all results of the page ‘Communication’ are summarized; red means negative and green positive. The results are ordered by importance.
Figure 16: Summary results 'Communication'

**Possibilities**
The experiences of the user with possibilities of IMT-MS; the influence of project duration, decision support, compatibility, system quality and system possibilities.

The absolute numbers in the tables below are the amount of users who checked this option; the other number is the percentage out of total (including 'Not applicable').

**SF12: Project duration**
32. Does the duration of the project have influence on the usage of IMT-MS?
33. If yes, what is the minimum duration of a project, where IMT-MS is effective? (in weeks)
34. Does the size of the project have influence on the usage of IMT-MS?
35. If yes, what is the minimum size of a project, where IMT-MS is effective? (in million euro)

<table>
<thead>
<tr>
<th></th>
<th>Influence: Yes</th>
<th>Influence: No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project duration</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>37,50%</td>
<td>62,50%</td>
</tr>
<tr>
<td>Project size</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>53,13%</td>
<td>46,88%</td>
</tr>
</tbody>
</table>
Increase Quality through Information Management

**SF19: Decision support**
Q36: Does IMT-MS support the decision making during a project?
Q37: Are there sufficient possibilities to store the decision making in IMT-MS and Chapoo?

**SF20: Compatibility with other systems**
Q38: Is the compatibility of IMT-MS with other software/programmes sufficient?

<table>
<thead>
<tr>
<th></th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision support</td>
<td>9 28,13%</td>
<td>6 18,75%</td>
<td>10 31,25%</td>
<td>0 0,00%</td>
<td>7 21,88%</td>
</tr>
<tr>
<td>Decision storage</td>
<td>3 9,38%</td>
<td>10 31,25%</td>
<td>13 40,63%</td>
<td>1 3,13%</td>
<td>5 15,63%</td>
</tr>
<tr>
<td>Compatibility other systems</td>
<td>5 15,63%</td>
<td>9 28,13%</td>
<td>10 31,25%</td>
<td>2 6,25%</td>
<td>6 18,75%</td>
</tr>
</tbody>
</table>

**SF21: System quality**

**SF22: Flexibility of queries and reporting formats**

Q39: Do IMT-MS and Chapoo offer sufficient possibilities on these fields:

**SF23a: System possibilities: Document management**

Q41: Do IMT-MS and Chapoo offer sufficient possibilities for document management on these fields:
Increase Quality through Information Management

SF23b/c/d/e/f/g/h: System possibilities: Planning/Costs/Administration/Procurement/Human Resources/Safety department/Quality department

Q42: Do IMT-MS and Chapoo offer sufficient possibilities on these departments:

The question about importance of the questions leads to the ranking below. The top three is bold:

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF12 32. Influence duration of project</td>
<td>-17</td>
<td>5/6</td>
</tr>
<tr>
<td>SF12 34. Influence size of project</td>
<td>-27</td>
<td>8</td>
</tr>
<tr>
<td>SF19 36. Support decision making</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>SF19 37. Storing of decision making</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>SF20 38. Compatibility IMT-MS</td>
<td>-24</td>
<td>7</td>
</tr>
<tr>
<td>SF21&amp;22 39. Possibilities</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>SF23a 41. Document management possibilities</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>SF23 42. Department possibilities</td>
<td>-17</td>
<td>5/6</td>
</tr>
</tbody>
</table>

In Figure 16 all results of the page ‘Possibilities’ are summarized; red means negative and green positive. The results are ordered by importance.
Processes
Because of the integration of the Quality Management System (QMS), the processes defined in the QMS play an important role. These questions are about these integrated processes: alignment of IT infrastructure with QMS, process support, process improvement, process mapping and redesign of processes for IMT-MS.

The absolute numbers in the tables below are the amount of users who checked this option; the other number is the percentage out of total (including 'Not applicable').

**SF15: Adequate alignment of IT infrastructure with QMS strategy**
Q45: Are the processes of the Management System of Mobilis sufficiently integrated in IMT-MS?

**SF24: Process support**
Q46: Does IMT-MS support the processes of the Management System sufficiently?

<table>
<thead>
<tr>
<th></th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration processes</td>
<td>0</td>
<td>0,00%</td>
<td>3</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Process support</td>
<td>0</td>
<td>0,00%</td>
<td>2</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>

**SF25: Process improvement**
Q47: Does IMT-MS improve the usage of the processes used by Mobilis?

**SF26: Process mapping**
Q48: Are the Management System’ processes clearer because of IMT-MS?

<table>
<thead>
<tr>
<th></th>
<th>Not possible</th>
<th>Decreases</th>
<th>Remains the same</th>
<th>Improves</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process usage</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Process overview</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>
**SF26: Process mapping**

49. Is IMT-MS arranged in that way that the Management System' processes are justified?

**SF16: Redesign of QMS processes for integration in IMS**

50. Are the Management System' processes sufficiently redesigned to be integrated in IMT-MS?

<table>
<thead>
<tr>
<th></th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justification processes</td>
<td>0</td>
<td>5</td>
<td>11</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>16,13%</td>
<td>35,48%</td>
<td>9,68%</td>
<td>38,71%</td>
</tr>
<tr>
<td>Redesign processes</td>
<td>0</td>
<td>2</td>
<td>12</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>6,45%</td>
<td>38,71%</td>
<td>6,45%</td>
<td>48,39%</td>
</tr>
</tbody>
</table>

In Figure 20 all results of the page ‘Processes’ are summarized; red means negative and green positive. The results are ordered by importance.

**Ease of use**

The experiences of users about the ease of use of IMT-MS; the reliability of the system, ease of use in general, interface satisfaction and clarity of the homepage.
The absolute numbers in the tables below are the amount of users who checked this option; the other number is the percentage out of total (including ‘Not applicable’).

**SF17a: System reliability: Availability and reliability of data connections and IMT acces**
Q53: Are there enough connection possibilities to IMT-MS?
Q54: Is the connection to IMT-MS sufficiently fast and stable?

**SF17b: System reliability: Data security**
Q55: Do you trust the safety of stored data in IMT-MS and Chapoo?
Q56: IS IMT-MS sufficiently shielded for outsiders?

<table>
<thead>
<tr>
<th></th>
<th>Largely insufficient</th>
<th>Insufficient</th>
<th>Sufficient</th>
<th>Ample</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection possibilities</td>
<td>0</td>
<td>2</td>
<td>18</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>6,67%</td>
<td>60,00%</td>
<td>10,00%</td>
<td>23,33%</td>
</tr>
<tr>
<td>Speed/stability connections</td>
<td>0</td>
<td>4</td>
<td>14</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>13,33%</td>
<td>46,67%</td>
<td>6,67%</td>
<td>13,33%</td>
</tr>
<tr>
<td>Safety stored data</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>0,00%</td>
<td>10,00%</td>
<td>60,00%</td>
<td>13,33%</td>
</tr>
<tr>
<td>Shielding for outsiders</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>0,00%</td>
<td>20,00%</td>
<td>56,67%</td>
<td>20,00%</td>
</tr>
</tbody>
</table>

**SF18: Ease of system use**
Q57: Is IMT-MS easy to use?

<table>
<thead>
<tr>
<th></th>
<th>Very difficult</th>
<th>Difficult</th>
<th>Easy</th>
<th>Very easy</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of system use</td>
<td>2</td>
<td>14</td>
<td>10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>6,67%</td>
<td>46,67%</td>
<td>33,33%</td>
<td>6,67%</td>
<td>6,67%</td>
</tr>
</tbody>
</table>

**SF18a: Ease of system use: Interface satisfaction**
Q58: Is the homepage of IMT-MS clear?
Q59: Is the total arrangement of IMT-MS clear?

<table>
<thead>
<tr>
<th></th>
<th>Very unclear</th>
<th>Unclear</th>
<th>Clear</th>
<th>Very clear</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homepage</td>
<td>0</td>
<td>7</td>
<td>20</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>23,33%</td>
<td>66,67%</td>
<td>0,00%</td>
<td>10,00%</td>
</tr>
<tr>
<td>Total arrangement</td>
<td>2</td>
<td>12</td>
<td>14</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>6,67%</td>
<td>40,00%</td>
<td>46,67%</td>
<td>0,00%</td>
<td>6,67%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF17a Q53: Connection possibilities</td>
<td>-11</td>
<td>5</td>
</tr>
<tr>
<td>SF17a Q54: Speed/Stability connection</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>SF17b Q55: Safety of data</td>
<td>-28</td>
<td>6</td>
</tr>
<tr>
<td>SF17b Q56: Shielding for outsiders</td>
<td>-48</td>
<td>7</td>
</tr>
<tr>
<td>SF18 Q57: Ease of use</td>
<td>51</td>
<td>1</td>
</tr>
<tr>
<td>SF18a Q58: Clarity homepage</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>SF18a Q59: Clarity IMT-MS</td>
<td>-1</td>
<td>4</td>
</tr>
</tbody>
</table>
In Figure 21 all results of the page ‘Ease of use’ are summarized; red means negative and green positive. The results are ordered by importance.

![Figure 21: Summary results 'Ease of use'](image-url)
5.4. Interviews

After the survey interviews with the management director, head of the design department, head of the project preparation department, head of the quality department and head of the building process department are held. The interview below is based on the Success Factors and is partly based on the survey results; the results are shown to the interviewee and also in the interview below:

Clarity goal IMT-MS

**SF1: Clear and open goals and policy**

10. Is the underlying policy of IMT-MS clear?
10. Is het achterliggende beleid van IMT-MS duidelijk?

<table>
<thead>
<tr>
<th></th>
<th>Very unclear</th>
<th>Unclear</th>
<th>Clear</th>
<th>Very clear</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>14</td>
<td>18</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>40,00%</td>
<td>51,43%</td>
<td>2,86%</td>
<td>5,71%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100,00%</td>
</tr>
</tbody>
</table>

**SF1: Clear and open goals and policy**

11. Is the goal of IMT-MS clear?
11. Is het doel van IMT-MS duidelijk?

<table>
<thead>
<tr>
<th></th>
<th>Very unclear</th>
<th>Unclear</th>
<th>Clear</th>
<th>Very clear</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>7</td>
<td>24</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0,00%</td>
<td>20,00%</td>
<td>68,57%</td>
<td>11,43%</td>
<td>0,00%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100,00%</td>
</tr>
</tbody>
</table>

1. What is the goal of IMT-MS Mobilis wide?
2. What is the goal of IMT-MS within your department?
3. Are there measurable goals defined?

Motivation from different management layers

**SF2: Top management support**

12. Do you experience enough motivation/support from the management board to use IMT-MS?
12. Ervaar je voldoende motivaie/draagvlak vanuit de directie om IMT-MS te gebruiken?

<table>
<thead>
<tr>
<th></th>
<th>No support</th>
<th>Little support</th>
<th>Sufficient support</th>
<th>Ample support</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>14</td>
<td>8</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>11,43%</td>
<td>40,00%</td>
<td>22,86%</td>
<td>8,57%</td>
<td>17,14%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100,00%</td>
</tr>
</tbody>
</table>

**SF2: Top management support**

13. Do you experience enough motivation/support from the head of your department to use IMT-MS?
13. Ervaar je voldoende motivaie/draagvlak vanuit het hoofd van uw afdeling om IMT-MS te gebruiken?

<table>
<thead>
<tr>
<th></th>
<th>No support</th>
<th>Little support</th>
<th>Sufficient support</th>
<th>Ample support</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2,86%</td>
<td>28,57%</td>
<td>22,86%</td>
<td>22,86%</td>
<td>22,86%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100,00%</td>
</tr>
</tbody>
</table>
SF2: Top management support
14. Do you experience enough motivation/support from your direct supervisor to use IMT-MS?

14. Ervaar je voldoende motivatie/draagvlak vanuit je directe leidinggevende om IMT-MS te gebruiken?

<table>
<thead>
<tr>
<th>Support Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No support</td>
<td>5.71%</td>
</tr>
<tr>
<td>Little support</td>
<td>28.57%</td>
</tr>
<tr>
<td>Sufficient</td>
<td>20.00%</td>
</tr>
<tr>
<td>Ample support</td>
<td>22.86%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>22.86%</td>
</tr>
</tbody>
</table>

| Total           | 100.00%    |

SF2: Top management support
15. Do you experience enough motivation/support from your colleagues to use IMT-MS?

15. Ervaar je voldoende motivatie/draagvlak vanuit je collega's om IMT-MS te gebruiken?

<table>
<thead>
<tr>
<th>Support Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No support</td>
<td>8.57%</td>
</tr>
<tr>
<td>Little support</td>
<td>25.71%</td>
</tr>
<tr>
<td>Sufficient</td>
<td>51.43%</td>
</tr>
<tr>
<td>Ample support</td>
<td>5.71%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>8.57%</td>
</tr>
</tbody>
</table>

| Total           | 100.00%    |

4. Is it necessary to gain motivation from every management layer to work sufficiently with the system?
5. How can this motivation be improved?

Explanation/training
SF5: Adequacy of training
18. Is the training/explanation that is provided sufficient to work well with IMT-MS?

18. Is de training/uitleg die aangeboden wordt voldoende om goed te werken met IMT-MS?

<table>
<thead>
<tr>
<th>Training Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No training</td>
<td>37.14%</td>
</tr>
<tr>
<td>Insufficient</td>
<td>31.43%</td>
</tr>
<tr>
<td>Sufficient</td>
<td>22.86%</td>
</tr>
<tr>
<td>Ample</td>
<td>0.00%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>8.57%</td>
</tr>
</tbody>
</table>

| Total            | 100.00%    |

6. Is a course/training necessary to work sufficiently with IMT-MS?
7. What should be explained during a first explanation about IMT-MS?
8. Should there be a difference in explanation/training with employees of Mobilis and employees of alliance partners?
Support IMT-MS

SF11a: Quality of support service
26. Is the support for IMT-MS from the building process department sufficient?
26. Is de ondersteuning van IMT-MS vanuit de afdeling Bouwproces voldoende?

<table>
<thead>
<tr>
<th>Tijdvak</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largely insufficient</td>
<td>2,94%</td>
</tr>
<tr>
<td>Insufficient</td>
<td>14,71%</td>
</tr>
<tr>
<td>Sufficient</td>
<td>58,82%</td>
</tr>
<tr>
<td>Ample</td>
<td>0,00%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>23,53%</td>
</tr>
</tbody>
</table>

9. Is the support from the Building Process department and the Quality department sufficient?

Decision making support

SF19: Decision support
36. Does IMT-MS support the decision making during a project?
36. Ondersteunt IMT-MS de besluitvorming binnen een project?

<table>
<thead>
<tr>
<th>Tijdvak</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No support</td>
<td>28,13%</td>
</tr>
<tr>
<td>Little support</td>
<td>18,75%</td>
</tr>
<tr>
<td>Support</td>
<td>31,25%</td>
</tr>
<tr>
<td>Much support</td>
<td>0,00%</td>
</tr>
<tr>
<td>Not applicable</td>
<td>21,88%</td>
</tr>
</tbody>
</table>

11. Should decision making support be one of the functions of IMT-MS?
12. What kind of decisions should be taken on basis of IMT-MS? And on which level?

Differences tender and realisation phase

13. What are (in short) the biggest differences between the tender and realisation phase?
14. Is IMT-MS sufficiently adapted to these differences?

Budget

15. Is there a budget set for the full development and implementation of IMT-MS?
Clients/Alliance partners/Subcontractors/Suppliers
SF13: Customer involvement
SF14: Supplier involvement

16. What are the requirements of client to such a system?
17. What is the opinion of clients about the system until now?
18. What are the requirements of Alliance Partners/Subcontractors/Suppliers to such a system?
19. What is the opinion of Alliance partners/Subcontractors/Suppliers about the system until now?
20. Is there an affiliation with the rest of TBI with this system?

Team structuring
SF10: Assigning of responsibilities

21. How is a project team structured?
22. How are the responsibilities in a project team divided?
23. Should a project team be structured otherwise because of IMT-MS?

New contract forms
SF12: Project duration

24. Is the design process changed because of new contract forms?
25. Does IMT-MS help with this changed design process?

Knowledge management

26. What happens with the stored data after completion of a project?
27. Is the work method with IMT-MS also evaluated after a project?
5.5. Interview results
In this paragraph the five interviews are summarized. The complete interviews can be found in Appendix E.

Clarity goal IMT-MS
SF1: Clear and open goals and policy

1. What is the goal of IMT-MS Mobilis wide?

In general:
To realise successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent.

Information management:
To control and optimize the handling of the streams of information during projects and have one data storage facility which is accessible for everybody who needs the data. IMT-MS should become a platform of knowledge.

Quality management:
To create process-wise quality improvement and have consistent steps between the first contact with the client and completion of projects. The company should be unified in working methods, but also in providing information to external parties.

2. What is the goal of IMT-MS within your department?

Management
Better and faster insight in streams of information about projects that are important for the management.

Design
Systems Engineering is developed as a tool to control the design process. The client comes with functional requirements and as a contractor you have to translate these requirements and in the end verify and validate these requirements; IMT-MS is ideal to organize this. The tool IMT-MS forces the designer to make the design according to the process.

Project preparation
No distinction between the goals of Mobilis and the goals of the project preparation department.

Quality
Partly the same goal as the company goal. The integration of the Management System in IMT-MS creates a unified work process; the goal of this is to create a standard work method and to have everybody work in the same way. Another advantage is to create a unified documentation with a standard library, standard work plans, etc. The added value for the Quality department is that more data can be extracted from IMT-MS and the data is inserted in a fixed method; eventually trends can be easily extracted because of this method.

Building process
The building process department does not have a specific goal with IMT-MS, because it is the developer and administrator of IMT-MS. The incentive and application are not at the building process department.

3. Are there measurable goals defined?

In general
- The goals of IMT-MS can be interlinked with the general company goals; return goals, limiting failure costs, optimizing staff deployment, etc. The introduction of IMT-MS can help to reach these goals. The benefit of IMT-MS on these goals is not directly measurable.
Short term

- Write a whitepaper with information about the goal of IMT-MS, how the system works and what you can do with the system.
- A company-wide kick-off in the first quarter of 2014.
- To produce a sufficient tool that is user friendly.
- To create enthusiasm among users and embrace the work method.
- To link 2D-GIS/3D drawing to IMT-MS.

Long term

- To have the management actively use IMT-MS as a management tool; to create a system which makes it easy for the management to extract the core information about projects.
- To add the ‘non-primary process’ departments like the financial, HR and administration department to the system.

Motivation from different management layers

SF2: Top management support

4. **Is it necessary to gain motivation from every management layer to work sufficiently with the system?**

Yes, if you don’t show motivation to work with the system as management the people below also won’t be motivated to use the system. A manager should be a role model in this case, but also listen to the comments of the employees and have a critical look at the application of the system.

The management board looks at the system in a more abstract way; they know the system exists and supervise the development, but don’t know every detail of the system and don’t need to know these details. The management board should give support and give space to develop the system, but the department heads should develop the system and motivate the employees. The motivation from the management board is only a small part, but one of the challenges is to find a way to show the management board’s ambition to the employees in the layers below, because there lies a gap now.

A difference lies with the young employees and the ‘experienced’ employees. The experienced employees have seen the implementation of different systems like Quality Management Systems (QMS) and Systems Engineering (SE) in the past decades. The implementation of these systems was in the beginning difficult, but in the end meant to be useful and rewarding for companies and the construction sector. The experienced employees are in general more difficult to motivate, because of the experience they have with struggling of implementation of older systems. They also rely more on experience in ‘traditional’ construction than younger employees.

Young employees are in general more enthusiastic in new systems and also in new technology. Therefore they are more enthusiastic to start with a new system and to investigate a new system. The young employees are in this case less difficult to motivate than the more experienced group and the young employees should motivate the more experienced employees, which is a difficult matter.

5. **How can this motivation be improved?**

The results from the survey show that the user experiences the least motivation from the management board related to the department heads, the direct supervisors and the colleagues. The motivation works twofold; the management board has to motivate the users to use the system, but the heads of the department should also motivate the management board to use the system more and extract more data out of the system.

The management board could show their motivation in a quarterly meeting with the whole company, which is already shown once during a meeting. The heads of the department and the developers of the system should
show the management board what they can do with the system, so the management board will use the system more, which works motivational for the user. If the user sees that the management board uses IMT-MS actively, this will motivate the user to put the right information in the system.

After the incentive and decision of the management board to develop and implement the system the execution of development and implementation is the responsibility of the department heads and therefore they have to create motivation among the users of the system. The management board is one layer above the heads of the departments and is not directly responsible for the development and implementation.

The project leaders have to show the results of a project every quarter of the year to the management board in a progress report. They have to summarize the information about the project to explain the progress, planning, quality, finances, relation with the client, etc. of the project in a short time. IMT-MS should provide the project leader with the right information for the progress report to communicate this to the management board. The management board has to summarize the progress reports to the supervisory board. If the way of summarizing information will be much easier by means of IMT-MS, this will be a great advantage for the project leader, but also for the management board. This will create motivation to use the system for the management board, the project leader, but also for the users beneath the project leader.

Create motivation by showing the necessity of the system:

- The complexity of the construction sector and requirements of the client make such a system a necessity.

Create motivation by indicating the proven benefits:

- Easier and clearer to provide client with as-built drawings (A50 project).
- Knowledge sharing becomes easier; can be compiled in library.

Explanation/training
SFS: Adequacy of training

6. Is a course/training necessary to work sufficiently with IMT-MS?

A real course with a long explanation is not necessary, because as with many programs it is best to learn it by using it. But a short explanation about the basic functions and the goal of the system is necessary. When users are working with the system, supervision is necessary to be able to have a quick explanation of the software for the user when it’s necessary. So it is better to focus on intensive guidance at the beginning of a project and weaken the intensity of the guidance during the projects. This is more effective than an intensive course at the beginning of a project.

A whitepaper of 10-20 pages is currently written (November 2013) to create an outline of the ambition, strategy and vision of IMT-MS. This whitepaper will be used to inform the employees of Mobilis, the employees working in alliances, the client and external parties who work on EMVI plans. This whitepaper will also be used to present IMT-MS company-wide.

7. What should be explained during a first explanation about IMT-MS?

The whitepaper (as mentioned at the question above) will be the first short explanation of IMT-MS. Furthermore the following points should be mentioned at a first (oral) explanation:

- The goal of the system; broadly and specific for the project.
- Why it contains the content.
- The Management System; the pyramid structure of the system and how it is structured further.
Increase Quality through Information Management

- The personal page.
- Which resources are used; Relatics and Chapoo.
- What you can find in general in IMT-MS and where.

After the first explanation a more specific explanation per target group is possible. The guidance at the beginning should also be intensive.

8. **Should there be a difference in explanation/training with employees of Mobilis and employees of alliance partners?**

Within an alliance you work for the project and less for the company, which means that everybody should get the same explanation. Alliance partners should only get a short explanation about the Quality Management System (QMS), because the processes in the QMS are proprietary processes of Mobilis.

Hired specialists who only use a specific part of IMT-MS should only be explained the part they use and the goal and structure of the system in general; not a complete explanation of the system.

The usefulness and necessity of the system should be explained to foreign alliance partners, because they are often not used to the Dutch way of working and the necessity of certain systems.

**Support IMT-MS**

**SF11a: Quality of support service**

**SF11b: Knowledge of support provider in construction**

9. **Is the support from the Building Process department and the Quality department sufficient?**

There is a difference between the Building Process (BP) engineer and the Quality manager, because the BP engineer is directly involved in the project team and supports the project team, while the Quality manager is indirectly involved and only acts when more guidance is needed for people who don’t know the processes. But both employees are there to support the project. The system is currently still in development, which means the support and guidance is not the most efficient because there are different versions used on projects.

10. **What is the future vision on this support; should it stay such intensive support?**

The support of both departments will decrease. A version of IMT-MS will be ‘frozen’ and during the use of the system remarks will be noted and they will be processed during an update for a next version, which makes it clearer for the user.

The role of the BP engineer will change when IMT-MS will be completely implemented, because many of the Systems Engineering tasks which they are doing now, will become the tasks of the Project Preparation and Design departments. With a clear and logical system this is possible and the BP engineer will aid in guidance in this matter during a project. The BP department will always have to make a ‘clone’ of the standard IMT-MS adapted to the project.

The Quality department is currently busy with the transforming of the process of the QMS to fit in IMT-MS, but with these processes finished, the Quality department will focus on checking if the defined processes are sufficiently followed by users. IMT-MS will aid in this process, because the registrations, validations and verifications are shown in the system and can also be seen by the Quality department.

**Decision making support**

**SF19: Decision support**
11. *Should decision making support be one of the functions of IMT-MS?*

This is a function of the system which is still under development and is not yet completely functional, but it should become a function of IMT-MS. Experienced project leaders do know when to make a decision and based on what kind of information, but the system can help younger project leaders to know the deciding and review moments according to the process that is visualised in IMT-MS. In this matter employees on every level should use the system correct to extract the right information for a decision.

In another way the progress can easily be shown of a project by showing the amount of accepted documents in a certain phase; this can also be decisive for the decision to go to the next phase.

12. *What kind of decisions should be taken on basis of IMT-MS? And on which level?*

- Decisions about the process; GO / NO GO moments.
- Design choices.
- Financial decisions.
- Planning decisions.
- Determine organizing chart.

**Differences tender and realisation phase**

13. *What are (in short) the biggest differences between the tender and realisation phase?*

The biggest difference lies in the level of design in detail; deliberate choices are made in the tender phase to design specific elements not in detail. In the realisation phase the complete design has to be made to build the project, so everything should be designed in detail. Also other processes are necessary during the realisation phase, like control and testing.

The finances during the tender phase are not fixed, but they are in the realisation phase, which makes a difference for the process. The client will test the contractor more if the requirements are met during the realisation phase and the process should be in order to meet these requirements. It is not completely necessary to have the process completely in order during the tender phase, but it is necessary during the realisation phase.

It is still necessary to transfer the major part of the tender team to the team that is going to the realisation phase, because knowledge will be lost if this doesn’t happen. The information that is stored in IMT-MS during the tender phase is not sufficient to continue in the realisation phase without the people that made the decisions; there will always be some part of data that is not stored.

14. *Is IMT-MS sufficiently adapted to these differences?*

Yes. The viewpoints from the tender phase should not change in the realisation phase, therefore the data will be ‘frozen’ after the tender phase and further used in the realisation phase. The transfer from the different phases is therewith sufficiently secured, because the data of the tender phase is still available in a dossier.

**Budget**

**SF3: User involvement development phase (SF3a) and implementation phase (SF3b)**

15. *Is there a budget set for the full development and implementation of IMT-MS?*

There is an approximate amount of hours set for the development and implementation, no budget. The development of such a system is pioneering work and it is better to not block this creative process in budget or time. The goal of development should stay clear and should be measured during the process.
Almost no external parties are hired for the development and implementation; the development is done
internal and the training is also given internally.

**Clients/Alliance partners/Subcontractors/Suppliers**

**SF13: Customer involvement**

**SF14: Supplier involvement**

16. **What are the requirements of client to such a system?**

The main requirements of the client are to be certified; mainly the ISO9001 (Quality Management) and they
can also ask the ISO14001 (Environmental Management) and the ISO15288 (Systems Engineering).
Furthermore, the process is per project defined in the Requirement Specification 2 (Vraagspecificatie 2 (VS2));
in this document is stated what the client requires about the process. Communication between the client and
contractor happens preferably by a standardised way.

17. **What is the opinion of clients about the system until now?**

IMT-MS is mainly developed for the sake of Mobilis, not for the client. The only experiences of the client with a
project completion until now are with a former version of IMT-MS; the as-built drawings and final
documentation of the project were quickly delivered, partly because of the system, which was a positive
experience of the client.

18. **What are the requirements of Alliance Partners/Subcontractors/Suppliers to such a system?**

Before a project there is decided which system of which alliance partner will be used throughout the project;
systems are not combined. This means that employees of Mobilis will have to work with the system of an
alliance partner in the future instead of IMT-MS.

The subcontractors and suppliers are not yet involved in the system, but they should provide their information
in the system and should also be able to extract information from the system. The infrastructure sector lacks
behind on this topic; the residential and non-residential construction sector is further ahead on this topic.

19. **What is the opinion of Alliance partners/Subcontractors/Suppliers about the system until now?**

No opinion until now.

20. **Is there an affiliation with the rest of TBI with this system?**

From the holding TBI no systems are imposed. With Croon an initiative has been taken to integrate both
systems for further cooperation; especially for tunnel construction projects. A BIM group is created within TBI
to share knowledge about this topic, but it is not the meaning to create one system for all of the companies
within TBI, because the processes are different in the different construction sectors.

Before the joining of other companies in IMT-MS, the system should work properly at Mobilis itself.

**Team structuring**

**SF10: Assigning of responsibilities**

21. **How is a project team structured?**

In the ideal situation a project team is structured on the basis of competences and skills and a good ratio
between system thinkers and more practical thinkers. Currently, the emphasis lies on the technical
competences above the system competences. In practice, the right person also has to be available for the right
function, which is not always the case.
22. How are the responsibilities in a project team divided?
23. Should a project team be structured otherwise because of IMT-MS?

A project team will not be completely otherwise structured because of IMT-MS, but the experience with IMT-MS can play a role in the future by structuring a project team. Also the employees have to work more structured because of IMT-MS, which can play a role in the future.

New contract forms
SF12: Project duration

24. Is the design process changed because of new contract forms?

New contract forms have helped to create a more conscious iterative design process. The design solutions have to come from the contractor, not from the client, because the contractor has his expertise in this area.

25. Does IMT-MS help with this changed design process?

The Maintenance part of a DBFM (Design, Build, Finance, Maintenance) contract is not yet integrated, but this is developed. The Finance part of the DBFM is more difficult to integrate. Furthermore, BVP (Best Value Procurement) is also not yet integrated in IMT-MS because there are doubts with this kind of procurement.

Knowledge management

26. What happens with the stored data after completion of a project?

The data of a project is archived, mostly digital, but not yet effectively. The good ideas of a project should be stored in a database sorted by subject or theme which is easily accessible. Eventually it is the intention to create elements in a database and to design with these elements; data should be available and easy to find for a project team.

Knowledge management is a different subject in the construction sector and lots of companies are working on this subject. Some companies have an extensive database, but what matters with knowledge management is to find the right experiences about a project and how to store this; this is mainly about persons. A system like IMT-MS can never replace the creativity of employees, but it can support the employees by providing the right information.

27. Is the work method with IMT-MS also evaluated after a project?

After the tender projects there have been evaluations which led to improvements of IMT-MS.

5.6. Interim conclusion

The results of the survey and interviews are answered with the following research question:

- What are the experiences of the users with IMT-MS during the tender phase, what are the considerations of the developers and managers regarding these experiences and what is the vision on the implementation process?

This research question will be partly answered in this interim conclusion, but also in the interim conclusion of the next chapter Discussion, because the results are further discussed in that chapter. Because different topics are mentioned in this research question the topics are answered separately.

Survey

To gather the experiences of users of IMT-MS and managers working with IMT-MS, a survey is conducted
among the users and managers based on the Success Factors defined in paragraph 3.5. The survey is conducted according to six different subjects:

- Personal data
- Development IMT-MS
- Communication
- Possibilities
- Processes
- Ease of use

These are also the pages of the survey and after every page (except the page ‘Personal data’) is asked what the importance was of the questions to come to a ranking of the questions based on the user’s opinion. This can also be related with the importance of the Success Factors.

The results of the survey are further discussed in the next chapter; Discussion.

**Interviews**

To gather the considerations about IMT-MS with the developers and managers five interviews have been conducted among the management director and department heads that influence the development and implementation of IMT-MS in the organisation and in projects. The interview questions are based on the Success Factors and on the results of the survey. Furthermore, questions are asked that couldn’t be asked to the end users in the survey.

The results of the interviews will be combined with the results of the survey according to the success factors and further discussed in the next chapter; Discussion.
6. Discussion

6.1. Introduction
Because the results of the survey and interview are presented in an objective way in chapter 0, in this chapter the results are discussed in a more subjective way. This is done by interpreting the results according to literature, but mainly with the opinion of the author on the discussed matters with the following research question in mind:

- What is a clear and consistent interpretation of the results?

IMT-MS is considered a case study for the general research on this topic. This chapter is ordered by the categories used in the survey. The results of the interview are combined in these categories.

6.2. Personal data
The personal data is the first page of the conducted survey and the meaning is to come to a better understanding of the users. The age, education, work experience, company, department, etc. of the user of IMT-MS is asked.

- The survey has been executed among 86 users and in the end 35 respondents. This is not a large population for a survey, but these are the only users of the system.
- The average age is about 39,8 years and the average years of experience is 16,8 years, which makes the project teams quite experienced, what is expected in a large project team.
- From the 35 respondents, more than half of the respondents (52,88%) is not working for Mobilis, which gives a clear insight of the opinion on projects (because often a project team is composed from different companies), but gives a slightly clouded insight for the implementation in the company.
- Most of the users work for the design department of project preparation department, which is logical for a project team. Because the surveyed users all work on tender projects, a relative low amount of execution staff is questioned.
- Users also mentioned projects where they used IMT-MS where a former version of IMT-MS is used or another information management tool is used. This clouds the results a little, because on these projects IMT-MS was not completely functional.
- A relative large percentage of users with a leadership function (31,43%) have answered the survey.

6.3. Development IMT-MS
On this survey page the goals and policy of IMT-MS, the support from different management layers, the user involvement, adequacy of training and computer experience is questioned. Most of the results on these subjects are also incorporated in the interviews, because the management of Mobilis has a clear opinion on this matter.

SF1: Clear and open goals and policy
Q1: What is the goal of IMT-MS Mobilis wide?
Q2: What is the goal of IMT-MS within your department?
Q3: Are there measurable goals defined?

- The underlying policy is not very clear with 40,00% unclear, but the policy is also less important than the goal, as opinion of the user.
- The goal is quite clear, with 80% clear to very clear. The goal is considered the most important by the user on the ‘Development IMT-MS’ page. Therefore it is also further discussed with the interviews.
- The goal has made clear on different levels with the interviews. The general goal is: “To come to a successful project control according to the company’s quality plan where process management and
information management go hand in hand and where the processes are explicit and transparent.” This combines the information management goal and the quality management goal, which is one of the main purposes of the integration.

- The goals of IMT-MS are interlinked with the company goals. It is difficult to prove by numbers if the company goals are met because of IMT-MS, which makes it harder to prove the efficiency of IMT-MS.

SF2: Top management support

Q4: Is it necessary to gain motivation from every management layer to work sufficiently with the system?

Q5: How can this motivation be improved?

- Comparing the results of the different management layers (Management board, Department head, Direct supervisor, Colleagues) shows that the least support is experienced from the management board and (51,43% no support to little support) and the most support from the department heads. Also the direct supervisor and colleagues score almost as high as the department heads. But all score not very high.
- The motivation of the management board can partly be explained because the users are not all from Mobilis and the management board is often not directly involved in projects. Also, the management board is further away in management layers from the user.
- Result from the interviews shows that it is necessary to gain motivation from every management layer, but in a different way. It is also more difficult for the management board to show motivation, because they are ‘further away’ from the user.
- One of the possibilities to show their motivation is by actively using it, but the management usage is still in development. The management should extract the basic information from projects out of IMT-MS and create interaction in this way between the users who put the information in IMT-MS and the management that extracts the information.
- There are different generations in a company; the younger generation that enthusiastically starts with a new software tool and the more experienced generation that is less enthusiastic. In a project team the younger generation can motivate the more experienced generation to work with IMT-MS. Also, the developers can learn from the more experienced generation.
- It is easy to motivate users by stating the necessity and benefits of the system. The necessity of the system can be shown, but the benefits are not yet proven; there are only expectations. Therefore it is difficult to show the benefits to the user.

SF3: User involvement development phase (SF3a) and implementation phase (SF3b)

Q15: Is there a budget set for the full development and implementation of IMT-MS?

- The majority experiences no involvement to little involvement (62,86%) with the development phase, which is logical, because most of the users are not directly involved in the development. Most of the heads of the departments are involved with the determining of the processes of the Management System, because they become ‘process owner’ (see chapter 4.4).
- Even more users experience no involvement to little involvement during implementation phase (71,43%), which was not expected. Mostly users are not that much involved during development, but more during implementation.
- Both of the involvement questions are considered as not important for the implementation by the user, so it is not a big issue for the implementation that these questions got negative response.
- Only an approximate amount of hours is set at the beginning of the development to not block the creative process of development. The development, implementation, training and support is also kept internally to reduce costs and keep knowledge in the company.

SF5: Adequacy of training

Q6: Is a course/training necessary to work sufficiently with IMT-MS?
Q7: What should be explained during a first explanation about IMT-MS?
Q8: Should there be a difference in explanation/training with employees of Mobilis and employees of alliance partners?

- 37.14% got no training/explanation and 31.43% got training/explanation, but thought it was insufficient. The training is also not considered the most important by the users, but it still is not a high score and not expected that low beforehand. Therefore this topic is also discussed with the interviews.
- At the start of a project there should be a short explanation for everybody; this can be done according to the whitepaper that is written now. Guidance after this first explanation is more useful than an extensive course, because with using the system you also learn how to use it.
- The content of the first explanation should be about the goal of IMT-MS, the processes of Mobilis and how you can find your way in IMT-MS. It is not useful to show every button or function of IMT-MS to the user.
- When a project team is started with an alliance partner, everybody should get the same explanation, because you work as a project team. This is a difficult, because Mobilis employees already know about the processes used at Mobilis, but alliance partners probably do not.

SF6: Computer experience of team members

- 74.29% thinks the project team members have sufficient or ample experience to work with IMT-MS, so most users think the computer experience is sufficient. It is also considered the least important on this page.

6.4. Communication

Because IMT-MS is used for communication between users the openness of communication, exchange of data, collaboration, responsibilities and support quality is asked to the user. This is partly in comparison with former systems; the improvement in this matter is asked.

SF7: Open and effective communication

- The majority thinks IMT-MS leads to little open and effective communication (44.12%) and reasonable open and effective communication (38.24%). This is a quite average score and nothing can be really concluded out of this data. The user thinks this is an important aspect of the implementation.

SF8: Exchange of data by team members

- The majority says that the exchange of information between team members does not change (41.18%) and 35.29% says that it improves. This is quite positive for this matter, because no change is also good, but improvement is better. Because this is the most important matter, it should be improved more.

SF9: Improvement of collaboration

- 58.82% says the collaboration within a project does not change. One of the functions of IMT-MS is to collaborate more with different departments; because it is now possible to work with different departments in the same project phase in the same system. The user does not experience it this way and thinks it is an important aspect. This should be partly be improved in the organisation, but also probably in the software.

SF10: Assigning of responsibilities

Q21: How is a project team structured?
Q22: How are the responsibilities in a project team divided?
Q23: Should a project team be structured otherwise because of IMT-MS?
55,88% thinks the roles and permissions are unclear, 29,41% thinks it is clear, which makes the roles and permissions unclear. An explanation could be that the survey is also about former versions of the system, where the assigning of responsibilities is less clear.

- A project team should be structured according to the competences that are necessary for the project; also a good ratio between system thinkers and more practical thinkers.
- An organizing chart of the project team, when defined for the tender phase or realisation phase, should be made visible in IMT-MS to make the responsibilities clearer and also to find the person with certain competences.

**SF11a: Quality of Support service**

**SF11b: Knowledge of support provider in construction**

**Q9: Is the support from the Building Process department and the Quality department sufficient?**

**Q10: What is the future vision on this support; should it stay such intensive support?**

- The provider of support during projects is mostly the Building Process (BP) department, the Quality department mainly provides support about the processes. Therefore it is a logical result that the BP department has 58,82% sufficient support according to the user and the Quality department slightly lower with 47,06%. The support from the BP department is also considered more important for the implementation.
- The BP department also has sufficient affinity with the construction industry to provide support for IMT-MS, 52,94% thinks this is sufficient. The Quality department scores lower on this topic with 41,18%.
- The support and guidance is not yet in the most effective way, because the system is still in development and both the BP department and the quality department are busy with the development. Nevertheless, the results are positive.
- In the future the support will become less intensive and the role of the BP department will change; the role of BP engineer will be partly the role of the Project Preparation and Design departments.

### 6.5. Possibilities

The experiences of the user with possibilities of IMT-MS; the influence of project duration, decision support, compatibility, system quality and system possibilities.

**SF12: Project duration**

**Q24: Is the design process changed because of new contract forms?**

**Q25: Does IMT-MS help with the changed design process?**

- The project duration is split up in the project duration in time (weeks) and the project size (in million euros). 62,50% of the users says that the project duration (in weeks) has no influence on the usage of IMT-MS and 53,13% thinks that the project size (in million euros) does have influence on the usage.
- Of the users that think the duration has influence on the usage of IMT-MS the average minimum lies on 21,64 weeks. The average minimum project size is 4.9 million euro.
- The project size and duration are not the most important for the usage of IMT-MS, but the contract forms are more important. With old contracts (RAW) Systems Engineering was not necessary, this became more useful with D&C contracts, because the client didn’t give designs, but technical or functional requirements. Therefore the contract form and given requirements are more decisive for the usage of IMT-MS than the project size and duration.

**SF19: Decision support**

**Q11: Should decision making support be one of the functions of IMT-MS?**

**Q12: What kind of decisions should be taken on basis of IMT-MS? And on which level?**
The majority (46.88%) thinks that IMT-MS does not support or give little support to decision making during projects. This could be caused by the fact that the opinion is given about different versions; with the processes less integrated in IMT-MS the system leads less to decision support.

A small majority (43.74%) says that the decision making can be stored sufficiently in IMT-MS and Chapoo.

Decision making support is still under development, what explains the low scores.

Experienced project leaders need IMT-MS less to make decisions than young project leaders. If the system is used correctly and everybody puts the right information in the system, IMT-MS can aid young project leaders in their decisions.

On the basis of the progress of the project shown in IMT-MS decisions can be taken.

SF20: Compatibility with other systems

The majority (43.76%) says that the compatibility with other software/programs is largely insufficient to insufficient. The reason could be that IMT-MS is still in development and the integration of other software packages like 3D design is currently in progress.

SF21: System quality

SF22: Flexibility of queries and reporting formats

SF23: System possibilities; document management, planning, costs, administration, procurement, HR, HSE, Quality

The user is asked about the different possibilities on different fields; most of the functions are in general sufficient. The user thinks the general possibilities of the system are the most important of this page; these are the primary functions of IMT-MS. It is logical that these functions should work properly to have the system sufficiently implemented.

Two functions worth remark are the reporting function and the queries function; these both score 37.5% insufficient, which is low. These parts are under development; standard reporting formats and queries functions are now partly working or still under development.

Another function worth remark is the archiving/storage function; 75% says this is sufficient, which is high.

For the department possibilities most of the users said ‘not applicable’, because this is department specific. All departments are sufficient. The Quality department scores highest, because the system is partly developed by the Quality department.

Knowledge management

Q26: What happens with the stored data after completion of a project?
Q27: Is the work method with IMT-MS also evaluated after a project?

Knowledge management is not incorporated in the Success Factors and is also not incorporated in the survey. But knowledge management can aid IMT-MS to be successful for usage and for implementation.

The data of a project is mostly digitally archived.

Knowledge management is a different subject in the construction industry. A method is to have an extensive database with designs from former projects and the creative ideas used. The search function for this database is important to have a useful database. The best way is to create a link to person with the specific experience.

The intention is to create a database or library with elements and in the future design with these elements. Because of the uniqueness of projects in the infrastructure sector this will be difficult.

A system like IMT-MS can never replace the creativity of employees, but it can support employees by providing the right information.
6.6. Processes

Because of the integration of the Quality Management System (QMS), the processes defined in the QMS play an important role. These questions are about these integrated processes; alignment of IT infrastructure with QMS, process support, process improvement, process mapping and redesign of processes for IMT-MS.

On this page, ‘Not applicable’ is filled in relatively a lot, because the project team members that not work for Mobilis are not that familiar with the processes of the Management System of Mobilis. Also, because the processes are not fully integrated in the versions that are used until now, the results are not very valuable. If a survey can be held in about a year about the version with all processes integrated, the differences between these surveys can be more valuable.

SF15: Adequate alignment of IT infrastructure with QMS strategy
- 48,39% of the users think the processes are sufficiently integrated in IMT-MS.

SF24: Process support
- The majority (48,39%) says that IMT-MS support the processes of the Management System of Mobilis sufficiently.

SF25: Process improvement
- 35,48% of the users say that the usage of the processes used by Mobilis improves and 16,13% says that the usage stays the same. This is one of the main functions of IMT-MS, so this is a very positive outcome.

SF26: Process mapping
- The majority says that the processes become clearer because of IMT-MS, only a small part of the users say that the processes become less clear because of IMT-MS.
- The majority says that IMT-MS is sufficiently arranged to justify the processes.

SF16: Redesign of QMS processes for integration in IMT-MS
- The majority (45,16%) thinks that the processes are sufficiently redesigned for the integration in IMT-MS.

Differences tender and realisation phase
Q13: What are (in short) the biggest differences between the tender and realisation phase?
Q14: Is IMT-MS sufficiently adapted to these differences?
- The differences of the tender and realisation phase are not incorporated in the Success Factors, but they are mentioned in the report in paragraph 3.4 and they are important for the implementation plan (chapter 7).
- The biggest difference is the level of detail; in the tender phase only the important details are incorporated, for execution during the realisation phase all of the details should be designed. Therefore other processes are also necessary.
- The finances are not yet fixed in the tender phase, but they are in the realisation phase, which means that financial control is more necessary. The client will test the contractor also more during the realisation phase because of this reason; therefore you need to have your process in order.
- The knowledge of the tender team can’t be completely stored in IMT-MS; therefore team members of the tender team have to be transferred to the realisation team to keep the knowledge in the project.
The data and choices of the tender phase have to be ‘frozen’ in IMT-MS to continue with this data in the realisation phase.

6.7. Ease of use
The experiences of users about the ease of use of IMT-MS; the reliability of the system, ease of use in general, interface satisfaction and clarity of the homepage.

SF17: System reliability
SF17a: Availability and reliability of data connections and IMT-MS access
SF17b: Data security
- 70,00% of the users say there are sufficient to ample connection possibilities to IMT-MS. The connection is by internet, so with a well working internet connection it is possible to connect to IMT-MS and Chapoo.
- The majority (53,34%) thinks the speed and stability of connections is sufficient to ample, but there is still a group that thinks the speed and stability is largely insufficient to insufficient. This was expected beforehand, because the connection can be slow and is also experienced by some users as slow. The speed and stability of the connection is considered as important for the ease of use.
- The vast majority (73,33%) trusts the stored data in IMT-MS and Chapoo. The stored data in the tender phase is important, because there is often large competition among contractors to win a tender. Therefore data about the price and design choices should be kept secret during the tender phase.
- The safety of data also counts for the shielding for outsiders; the response on this matter is somewhat more negative, but still positive (60,00% sufficient, 20% insufficient). This is probably because different companies can have access to IMT-MS.

SF18: Ease of system use
SF18a: Interface satisfaction
- The ease of use, by far the most important factor on this page, is experienced as difficult to very difficult by 53,34% of the users. Because of the importance the ease of use should be improved or there should be more explanation/training available to make the usage more easy.
- The homepage of IMT-MS is experienced as clear by 66,67% and the total arrangement of IMT-MS is clear by 46,67% of the users and unclear by 40,00% of the users. The clarity of the homepage is more important than the total arrangement of IMT-MS.

SF13: Customer involvement
SF14: Supplier involvement
Q16: What are the requirements of client to such a system?
Q17: What is the opinion of clients about the system until now?
Q18: What are the requirements of Alliance Partners/Subcontractors/Suppliers to such a system?
Q19: What is the opinion of Alliance partners/Subcontractors/Suppliers about the system until now?
Q20: Is there an affiliation with the rest of TBI with this system?
- The success factors ‘customer involvement’ and ‘supplier involvement’ are not used in the survey, but they are used in the interviews.
- The client has no specific requirements on a system like IMT-MS, it only has to be certified. The client is also not involved; IMT-MS is developed to aid the employees of Mobilis.
- Before a project there is decided which system from which alliance partner is chosen; systems are not mixed up. This means that it is possible that employees of Mobilis will have to use the system of an alliance partner.
The subcontractors and suppliers are not yet involved in the system; this is one of the long term development plans. Eventually the subcontractors and suppliers should also get access to IMT-MS, insert their data and extract data out of it.

There is no system from the TBI holding, but an initiative has been taken to integrate the systems of Croon and Mobilis for tunnel construction projects. Other companies from TBI could also be involved in the future.

It is better to finish the development of IMT-MS and have it well implemented in the company, before other parties get involved in IMT-MS.

Knowledge management

Q26: What happens with the stored data after completion of a project?

Q27: Is the work method with IMT-MS also evaluated after a project?

Knowledge management is not incorporated in the Success Factors and is also not incorporated in the survey. But knowledge management can aid IMT-MS to be successful for usage and for implementation.

The data of a project is mostly digitally archived.

Knowledge management is a different subject in the construction industry. A method is to have an extensive database with designs from former projects and the creative ideas used. The search function for this database is important to have a useful database. The best way is to create a link to person with the specific experience.

The intention is to create a database or library with elements and in the future design with these elements. Because of the uniqueness of projects in the infrastructure sector this will be difficult.

A system like IMT-MS can never replace the creativity of employees, but it can support employees by providing the right information.

6.8. Interim conclusion

Answer to the research question:

What is a clear and consistent interpretation of the results?

Personal data

IMT-MS has no large amount of users, but the 35 respondents give a good overview of the end users of the system.

The opinions of the users in the survey are based on different projects they are working on and therefore also different versions of IMT-MS, which make the results not completely consistent.

52.78% of the respondents are not from Mobilis, but from other companies; this gives a good overview of the users of the system.

A relatively large percentage of respondents has a leadership function (31.43%).

Development IMT-MS

The goal and its clarity among the users is considered the most important by the users; 80% thinks the goal is clear to very clear.

The top management support is also considered important; support from the management board is most negative, from the direct supervisor most positive.

According to the interviews, the management board should also motivate users, but in a different manner than the department heads, because they are ‘further away’ from the end user.

The end user considers the training not very important and most users got no training or insufficient training.
Increase Quality through Information Management

- The training should be short and should be about the goal of IMT-MS, the processes of Mobilis and what is available in the system.

Communication

- The exchange of information is the most important and this improves because of IMT-MS according to the end user, compared to old systems.
- A project team should be clearly assigned for a project and visualised with an organizing chart in IMT-MS to make the responsibilities clear to everybody working on the project.
- The support service (Building Process department and Quality department) is sufficient.
- The support service should not only give training, but also intensive guidance during the beginning of implementation in the organisation or in a project.

Possibilities

- In general, the possibilities are sufficient.
- The decision making and storing of the decision making is not sufficiently included in IMT-MS. This function can help (young) project leaders to aid them in decision making according to provided information by IMT-MS.
- The results from the survey about department possibilities give a lot of ‘not applicable’, because it is difficult to define for another department if this is sufficient. This gives clouded results on this topic.

Processes

- Because 52.78% of the respondents does not work at Mobilis, they are not familiar with the processes of Mobilis that are integrated in IMT-MS. Therefore almost 50% of the respondents filled in ‘not applicable’, which gives somewhat clouded results.
- In general, the response about the integrated processes in IMT-MS is sufficient.
- The usage of the processes improves by using IMT-MS.

Ease of use

- The end user thinks the ease of use is important and that IMT-MS is not easy to use. This can partly be explained by the clarity of the whole system; the user thinks this is insufficient.
- The speed and reliability of the system is insufficient, which is important according to the user.
Increase Quality through Information Management

7. Implementation plan

7.1. Introduction
The theory of chapter 0 (literature study), the explanation of Mobilis in chapter 4 (Information Management and Quality Management Mobilis) and mainly the results of the survey and interview and discussion lead to this implementation plan. The data in the previous chapters is used to come to an implementation plan on organisation level and project level with the following research question in mind:

- What is an effective set of considerations to decide on applying IMT-MS and further recommendations on developing and implementing this system on organisation and project level?

In general, this chapter focuses on the implementation plan, except if the text is provided in the blue text boxes.

The text in the blue text boxes focuses on the case study at Mobilis.

In chapter 7.2 the implementation plan is described on organisation level. The implementation plan on project level is provided in chapter 0 and the resulting interim conclusions are summarized in chapter 7.4.

7.2. Organisation level
The first part of the implementation plan is the implementation on organisation level. The organisational implementation is split up in three parts; considerations, development and implementation. The considerations have to be discussed before starting the development of an IMT-MS within a company and are before the decision to start such a project. After the decision based on these considerations, recommendations on the development and implementation phase are given. This is visualised in the flowchart in Figure 22; the three steps (considerations, development and implementation) including the GO / NO GO moments for a company that wants to start with a system like IMT-MS.

![Flowchart implementation plan organisation level](image)

Figure 22: Flowchart implementation plan organisation level

The first GO / NO GO moment lies after the considerations; should the company start with the system or not? After the considerations the development starts; after development there is another GO / NO GO moment to realise if the system is sufficiently developed to be implemented in the organisation. If not, the system should be further developed. After the implementation phase there should be considered if the system is successfully implemented in the company and if the system should be further developed.

7.2.1. Considerations
Before adopting an Information Management System with integrated Quality Management System (IMT-MS) certain considerations have to be taken into account. These considerations are on organisation level, but also on project level (see paragraph 0). Considerations are about the question if an IMT-MS should be adopted and also how. The considerations on organisation level are (Fikkers et al., 2012):
Increase Quality through Information Management

- The financial position of the organisation; the expected workload, economic prospects and current financial position of the organisation in the construction sector.
  
  Decreasing workload until now due to financial crisis. The economic prospects of the construction industry show that the building output will grow after 2014 (Bouwend Nederland, 2013)

- A top-down organisation culture or bottom-up; this considers the influence of initiatives from the staff.

- The position of the management board; do they consider every challenge as an opportunity or are they more defensive?

- The position of the organisation in the chain; is the position leading or following?
  
  This position depends on the size of the projects; with small projects Mobilis is for 100% the general contractor, with medium-sized projects Mobilis is mostly leading and with large projects this is not always the case.

- The closest competitors; do competitors have a certain system or do they have plans to introduce such a system?

- The organisation culture; is the culture fit to change? The age and experiences of personnel are important, but also the character of the organisation; formal or informal.
  
  The average age of the current users of IMT-MS is 39.8, with the youngest 24 and the oldest 60.
  
  The average years of experience of the users is 16.8 with the shortest 0.5 years and the longest

- Computer experience of future users of the system. Do they have enough experience with software to work with the intended system?
  
  The users of Mobilis experience their colleagues to have sufficient experience to work with IMT-MS. Most employees of Mobilis of the project preparation and design department use the computer often, so a new software tool will not be a problem for these departments. Employees of the realisation department use the computer less, which should be taken in mind during development.

- What kind of software will be used? This will define the possibilities of your system. The connection to this system is also important, because construction projects can be everywhere. Therefore an internet connection is often used.
  
  Mobilis has chosen for the software Relatics in combination with Chapoo. The connection to both systems is by internet.

These considerations show the necessity for the organisation to develop and implement a system. If the discussed considerations are positive for the development of an IMT-MS, the development of the system can start.

For Mobilis these considerations already have been taken into account before the development and implementation of IMT-MS. The necessity for Mobilis comes from the complexity of the construction sector and the requirements of the client. The conclusion was that the development should be executed and IMT-MS is currently used in different projects in the tender phase and the realisation phase. The company-wide kick-off of IMT-MS is planned in the first quarter of 2014.

7.2.2. Development

SF1: Clear and open goals and policy

The first step of development is to define the goal of the organisation with the system. It is useful if the company goals are interlinked with the system goals. Because the company goals are often quite general, it is difficult to measure if these goals are reached with IMT-MS. Because the system is an integration of two systems, the information management and quality management can have a separate goal.
Increase Quality through Information Management

It is useful to define measurable goals that can be used during development to reach these goals, but also during implementation. During development the progress of development can be measured by the defined goals, which also gives an insight of the timeline. During implementation and after implementation there can be measured if the goals are reached and the benefits of the system can be proven according to the benefits.

| General goal: |
| To realise successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent. |

The interlinked goals with the general company goals:

- Sufficient return
- Limiting failure costs
- Optimizing staff deployment
- Good relation with client

| Information management: |
| Control and optimize the streams of information during projects and have one data storage facility which is accessible for everybody who needs the data. |

| Quality management: |
| Create process-wise quality improvement and have consistent steps between the first contact with the client until the completion of projects. To unify the company in working methods and providing information to external parties. |

Next to the general company goal it is also useful to define goals with IMT-MS for specific departments. It is possible that the department goals are the same as the company goals, but for some departments the goals will differ.

| Design department: |
| IMT-MS should force the designer to make the design according to the process. Organize and structure the functional requirements of the client and verify and validate these requirements. |

| Quality department: |
| Next to the quality management goals to create a unified documentation with standard library, standard work plans etc. To extract more data from IMT-MS where trends can be based on. |

**SF2: Top management support**

The management support is especially important to motivate users in the implementation phase, but the support is also useful during the development phase. For the development and redesign of processes the management layers are necessary, because they are ‘process owners’. Therefore the management board and the department head have to assist in the redesign of their processes.

It is also useful for the developers to have comments from the management board of department heads about the developments; this can also be considered support and can motivate the developers.

It can also be useful to publically announce the development of the new system and announce the goal of this new system in the organisation. Support can be created in this way and enthusiastic employees can aid in the development.
SF3a: user involvement development phase
Because the end user is no ‘process owner’ they aren’t qualified to decide about the processes, but enthusiastic employees can aid with testing before implementation. Testing of such a wide-spread software tool will be time consuming, so it should be well considered if this is useful.

The user of IMT-MS doesn’t think it’s important to be involved during the development phase and doesn’t experience sufficient involvement.

Only an approximate amount of hours is set for the development of IMT-MS to stimulate the creativity of the developers. A deadline has to be taken in mind, especially when the system will be implemented in projects.

SF20: Compatibility with other systems
SF21: System quality
SF23: System possibilities
Before and during the development there should be considered which functions are the most important for the success of IMT-MS. The basic functions are to manage the design and realisation of the project, but also to integrate supporting departments like the financial, HR, HSE or administration department in the software tool.

It will make the tool more extensive and therewith possibly less clear, but it can be an advantage for the company.

Document management is one of the main functions of the system; documents should be clearly structured in the system and easy to find.

The compatibility with other systems or the integration of systems is important for the success of the system in an organisation, because it is best for the integration of the organisation to have every department work in the same tool. It is highly probable that at the beginning of implementation not every system is integrated, this should ‘grow’ in time. This should be taken in mind by the developers.

The user thinks the primary functions of IMT-MS are sufficient, except the reporting and queries functions, which are still under development. To extract information out of IMT-MS it is important that these functions work sufficiently.

The integration of departments that are not directly involved in projects is a long term goal of IMT-MS.

The integration of 2D-GIS and 3D design are more technical, but they will be also integrated in IMT-MS.

SF15: Adequate alignment of IT infrastructure with QMS strategy
SF16: Redesign of QMS processes for integration in IMS
SF24: Process support
SF25: Process improvement
SF26: Process mapping
To use the processes of the Quality Management System (QMS) actively, the processes have to be well integrated in the system. The best way is to structure the system according to the existing QMS that is already implemented in the organisation, so employees are already familiar to this system. For every process, the information should be structured along this process.

The IT infrastructure should also be adequately aligned with the QMS. On the other hand, the processes have to be (re)designed to fit in the IT infrastructure. A balance has to be sought between these factors.
7.2.3. Implementation

SF1: Clear and open goals and policy
For the implementation it is necessary to have a clear goal and to propagate this goal to the end users. The goal presented in paragraph 7.2.2 has to be made clear to the end users; several options are possible to do this:

- By informing all employees during a company (quarterly) meeting.
- By the management board informing the department heads to have them further present it to the organisation (Top-down).
- By writing a memo to the complete organisation with an explanation of the goal of the system and how it will be used in the company.
- By presentation of the developers of the system to the organisation (Bottom-up).

During the implementation evaluation moments should be held with managers, developers and users to evaluate the usage of the system with the goal in mind. The implementation process or even the goal can be adjusted according to these evaluation moments.

At Mobilis IMT-MS the goal has been made briefly clear top-down to the company during a quarterly meeting and to the heads of departments during meetings with the management board.

A whitepaper is currently written about IMT-MS to inform the users, this will help to clarify the goal of IMT-MS among the users.

In general, the implementation of IMT-MS at Mobilis goes according these implementation steps:

1. Information management during projects / Systems Engineering tool
   a. Pilot projects tender phase
   b. Pilot projects realization phase
2. Integration of Quality Management System
   a. Pilot projects tender phase
   b. Pilot projects realization phase
3. Integration 2D-GIS / 3D Design / BIM
4. Integration other departments → Total company working in one software tool
   a. Finances
   b. Administration
   c. Etc.
5. Software tool fully integrated in company with all departments
6. Further integration/collaboration with other companies

SF2: Top management support
Top management support is an important issue for the implementation; even more important than during the development phase. The top management should define a strategy to implement the system and to motivate every user to use it properly. In this strategy responsibilities should be assigned who is responsible for the implementation.
Increase Quality through Information Management

Because the management board is ‘further away’ from the end user of the system than the department heads, it is more difficult to motivate the end user by the management board. Nevertheless, the management board has to show motivation to the end user, but less direct. The management board can motivate also by showing the user that the management board also uses the system.

The department heads have to actively motivate the usage of the system in their department. This will partly be done by the implementation during projects, but it also has to be supported in the organisation.

The direct supervisors are the most important for the end user for success of the system, according to the survey. The direct supervisor is closest to the end user and can influence the user easily.

Motivation among colleagues is also important. In general a difference should be made between generations in a company; in general the more experienced employees are harder to convince to use a new system than the younger generation. The younger employees can motivate the older employees by using the system and also actively show the advantages.

At Mobilis IMT-MS the goal has been made briefly clear top-down to the company during a quarterly meeting and to the heads of departments during meetings with the management board.

Further explanation is given by the developers at the start and during projects.

**SF3b: User involvement implementation phase**
The user should be more involved in the implementation phase than in the development phase, because the user has to start using the system during the implementation phase.

According to the user of IMT-MS the user involvement during the implementation phase is not important.

With the implementation of IMT-MS no external parties are involved, which means that the knowledge about development and implementation is kept inside the company. The training during projects is also done by the developers.

No strict budget has been set for the implementation; only an approximate amount of hours and a guiding timeline.

**SF5: Adequacy of training**
**SF11: Support quality**
**SF11a: Quality of support service**
**SF11b: Knowledge of support provider in construction**
The training and support of the system are important for the implementation process. The goal can be explained in a training, but also the processes that are integrated in the system and how the system is structured.

The most training will be given before projects; to inform the project team how IMT-MS will be used during the project. A more general introduction of the system can be given for the company; to make the goals of the system clear and how it will be used in the company, but also on projects.

The quality of the support service is also important, but mainly during projects. Sufficient support quality during projects can also lead to better implementation in the company. The support service can be from inside the company (the developers) or an external party to provide support for the software.

The support provider shouldn't only have knowledge about the processes and information management, but also about the construction industry and the projects that are executed, to come to specific support.
The trainings about IMT-MS at Mobilis are only given before or during projects; no training has given at the company not related to a project. With the presentation of the whitepaper in the beginning of 2014 a presentation about the functions of IMT-MS can also be given to create an idea of the functions among every employee.

The support for IMT-MS is kept inside the company; only the developers communicate with the software providers of Relatics and Chapoo. The experience of the user with the support departments (Building Process department and the Quality department) is sufficient and both departments have sufficient knowledge of the construction industry.

The function of the building process department will gradually flow in the Project Preparation department and Design department. Support with the tool will stay necessary, because there are always new users of the system. Also, the setup of a new project will be done by the building process department.

SF13: Customer involvement
SF14: Supplier involvement
A client has no requirements to a system like IMT-MS, except that it is certified. Documentation about IMT-MS can be provided to the client during tender or selection phases to prove the usefulness of the system.

Alliance partners are directly involved with the system, because the alliance partner will use the system alongside the Mobilis employees if there is chosen for the use of this system beforehand. This means it is also possible that this system is not used during a project.

It is also useful to involve the subcontractors and suppliers in the system, because they can provide useful information in the system and can extract useful information. The involvement of subcontractors and suppliers should happen when the system is fully functional and implemented. The subcontractors should only get limited access in the system, which makes it easier to provide and extract data and safer for company or project data.

Clients are not yet involved in IMT-MS; one client has only experienced the benefits of the completion of a project with a former version of IMT-MS.

Alliance partners are often involved during projects with IMT-MS; they get full access to the system.

Suppliers and subcontractors are not yet involved in the system; it is the plan to do so, but the system should run properly first. This could prove one of the advantages of the system.

Because Mobilis is part of the TBI Holding there is sought to be affiliation with other companies of the holding. The first developments are undergoing on a partly integrated system for tunnelling.

SF17: System reliability
SF17a: Availability and reliability of data connections and IMT access
SF17b: Data security
To create trust in your system, your system needs to be reliable. Nowadays the connection of newly developed systems is often by internet. Certain factors define this reliability; the availability and reliability of the data connections, the speed and stability of these connections and the data security.

If the system is difficult to access for the end user, it will not work motivational to use it. This also counts for the speed and stability of the connection. Because of the importance of certain company data and data during projects (especially in the tender phase) the data security has to be reliable.
Increase Quality through Information Management

IMT-MS (both Relatics and Chapoo) can be accessed by internet; you only need a user name and password. The connection possibilities are therefore sufficient, only the speed and stability of the system can be a problem. The system sometimes works slow or is not accessible, which doesn’t work motivational for the end user to use the system.

The security of data is trusted by the vast majority of users, which works motivational for users to store their data in IMT-MS.

**SF18: Ease of system use**

**SF18a: Interface satisfaction**
The ease of use of a system is a very important factor, especially with newly developed systems. If a system is easy to use, it will motivate the user; if it is not easy to use it will not motivate. The system will become easier to use if employees are used to the Quality Management System (QMS) and the system is structured in the same way as the QMS.

The users of IMT-MS say that the ease of system use is a very important factor and think the system is difficult to use until now. This can be because of the different versions over the past projects, which make it less clear for the user. It can also be the complexity and extensiveness of the system that make it difficult at first to use.

The users are satisfied with the homepage of IMT-MS, which is structured in the same way as the homepage of the Management System.

**SF19: Decision support**
It is a choice for a newly developed system to add decision support to it, but it can prove to be useful for the implementation. If a project leader can use the system to make decisions, it will motivate him to use the systems properly and he will motivate his staff to use the system properly, because the right information has to be inserted to make the decisions with the system.

Decision support is not well included in the system according to the end user (in the survey) and from the developers and managers (in the interviews). It can be one of the functions to make IMT-MS successful, because it can help project leaders to make decisions about their projects based on information. It can also help management layers above to aid in their decisions about the progress of a project.
7.3. Project level

The implementation plan on project level is divided into two steps; considerations and implementation phase. The development phase is left out on project level, because the development will only be executed at organisation level. The tender and realisation phase are added to elaborate on the differences between these phases, as mentioned in paragraph 3.4. The flowchart of the steps taken on project level is visualised in Figure 23. For a project considerations have to be taken into account to use the system with the project or not and in which phase to start with the system; the tender or realisation phase. After implementation in the tender phase there should be chosen if the system will also be implemented in the realisation phase. Afterwards there should be evaluated of the usage of the system with the project was a success or not.

![Figure 23: Flowchart implementation plan project level](image)

7.3.1. Considerations

The considerations taken in paragraph 7.2 to adopt an IMT-MS within an organisation also have to be taken on project level. Considerations if the IMT-MS is useful to use with the project and how (Fikkers et al., 2012):

- Are the projects mostly unique or on a routine basis?
  - Almost all projects of Mobilis are unique.

- Is the project share of the company in the project large or small; what is the influence of the company to use a certain system with the project?
  - This depends on the size of the projects; with small projects Mobilis often has 100% share, with medium projects Mobilis is often leading and with large projects it is unsure.

- Is the willingness to change of the project employees high or low?
- Do the project employees have sufficient knowledge to change the way of working?
- The integrated QMS creates more transparency in the work methods; therefore the contribution of every employee becomes also more transparent. Do the employees resist against these developments or do they agree with it?
- How many disciplines are involved with the project; more disciplines means more complexity, which makes it harder to implement, but more complexity can create also more return from the implementation.
- The contract form of the project; is it a complex contract form with many requirements the system can prove to be useful.
- The size and duration of the project; how longer and larger the project is, how more useful the system can be.

Another consideration is to choose the first project where the system will be implemented on, there are two options possible for this first project:

- On option is to simulate a former project with the new software; do not directly use it on a new project. This option has less risks, but can be less effective.
- Another option is to implement the new software on a new project; the best with less time pressure to get to know the new software and new work method. This is a more effective way for the implementation of the software, but it can have consequences on the project.
On the basis of these considerations a first project can be chosen to start the implementation of the system in a project.

### 7.3.2. Implementation

**SF1: Clear and open goals and policy**

The goal and policy of the system should be made clear before a project, but also the specific goal of the system for the project. This can correspond to the general goal of the project.

When multiple projects are completed with successful proven benefits from IMT-MS, these benefits can be shown at next projects to motivate the users. With the first project no benefits can yet be shown; in this case the necessity of the system can be shown. Such a system is necessary because of the complexity of the construction sector and the requirements of the client.

**SF2: Top management support**

For the implementation on project level of a new system the management layer (department heads and project managers) of the company or alliance plays a crucial role. The management layer has to ‘translate’ the formulated policy by the management board to a realistic and practical introduction and implementation plan for the project. They also have to ‘mobilise’ the management layers below to execute this plan.

### 7.3.3. Tender phase

**SF5: Adequacy of training**

**SF11: Support quality**

**SF11a: Quality of support service**

**SF11b: Knowledge of support provider in construction**

The training for the tender phase will differ with the training for the realisation phase. This is because of the difference in processes used during the tender phase and because of the difference in detail design.

The tender focusses on the winning of the tender; having an efficient design process and make tactical choices on which details should be designed to come to a good offer. The training should therefore focus on efficiently managing the client’s requirements to quickly start designing and calculating. Also to extract the right data out of the system to come to a sufficient offer for the client.

**SF10: Assigning of responsibilities**

The management board assigns the tender manager and at first a small tender team is assigned to analyse the documents. During the tender phase a larger tender team will be assigned. To make it for the complete tender team clear, the responsibilities of certain matters have to be assigned and registered in the system to create a clear view for everybody.

### 7.3.4. Realisation phase

**SF5: Adequacy of training**

**SF11: Support quality**

**SF11a: Quality of support service**

**SF11b: Knowledge of support provider in construction**

The training should go in further detail for the realisation phase because of the level of detail of the design and the different processes.

The realisation phase focuses on the control of the project with costs and planning. Therefore a well thought out design and work method is necessary to control the project. This design is made in different loops to come to further detail; this should be elaborated on during training.

**SF10: Assigning of responsibilities**

The realisation team is often partly based on the tender team, because the knowledge obtained during the
tender team should not be lost. Also, the tender team transfers the project to the realisation team, which makes it another start of the project than with the tender phase. The responsibilities assigned and registered during the tender phase can be partly taken over.

It can be useful for project team members to find specialists among the often large realisation team; a clear assigning of the responsibilities makes this possible.

7.4. **Interim conclusion**

To answer this research question an implementation plan on organisation level and project level is made:

- What is an effective set of considerations to decide on applying IMT-MS and further recommendations on developing and implementing this system on organisation and project level?

The implementation plan on organisation level and project level are separately discussed.

**Organisation level**

The implementation plan on organisation level is structured according to three steps, explained in Figure 24.

A company first has to take into account considerations if the company wants to develop and implement a system like IMT-MS. The considerations are mainly about the position of the company; the financial position, organisation culture, management board policy, competitors, computer experience, etc. According to these considerations a company should decide to continue with development or not.

- With the development, at first the goal of the system for the company should be thoroughly discussed. It is useful to interlink the company goals with the system goals, but it will be difficult to measure these goals according to the system.
- Top management support is most important to motivate users during implementation phase, but also during the development, because the top management are the ‘process owners’ of the Quality Management System. There should be considered if it is useful for the company to publically announce the development of the system.
- With the development there should be considered what has to be included in the system and what not. Certain functions can be kept away before implementation or added afterwards.
- The processes have to be well integrated in the system to gain sufficient usage from the end user. This requires intensive cooperation between the Building Process department and the Quality department to get the two systems sufficiently aligned. This should work in two ways; the IT infrastructure has to be adequately aligned with the processes, but the processes also have to be (re)designed to the IT infrastructure.

After the development phase there should be considered if the system meets the company requirements to be implemented. If yes, there should be continued to the implementation phase. If not, the system should be further developed.
Increase Quality through Information Management

- The goal is again very important for the implementation phase; the goal should be made adequately clear to all personnel that will use the system.
- Top management support is very important for the implementation phase; the management board should show to the user that they support the system and the department heads have to implement the system in their departments and motivate users to use it.
- The training is important for the implementation phase, but should be short for the end user. What has to be in the training; the goal of IMT-MS, the processes that are integrated and how the system is structured.
- After the training, intensive guidance for the user is necessary by the support departments.
- The system should be kept reliable during usage to create confidence for the end user to use the system.

After the implementation in the company, there should be considered if the system is a success or not. If it is a success, no or minor change is necessary. If it is not a success, the system should go back to the development phase to develop the system to a successful system.

Project level
The implementation plan on organisation level is structured according to three steps, explained in Figure 25.

![Flowchart implementation plan project level](image)

Figure 25: Flowchart implementation plan project level

For a company certain considerations have to be taken account if IMT-MS will be used in this project. Also, if the system will be used in the tender phase first and afterwards in the realisation phase or only in the realisation phase. The considerations before a project are; uniqueness of the project, company share in the project, knowledge of employees, amount of disciplines involved, contract form, etc. With these considerations the company has to decide to continue with implementation or not.

- With the implementation in a project the goal should be clearly announced to the project employees; from within the company and from outside the company.
- The project managers and department heads play a crucial role for the implementation in a project; this management layer has to ‘translate’ the vision of the management board to make it specific for this project and clear for the users in the project.
- Because of the difference in design detail and processes during the tender phase, a different explanation should be given than before the realisation phase. The explanation for the tender phase should focus on managing the client’s requirements and efficiently winning the tender.
- The training for the realisation process should contain explanation about the other processes that are involved during the realisation phase.
- If there is started with the system in the realisation phase, the explanation of the tender phase and the extra explanation for the realisation phase should be included.
8. Conclusions
This thesis aims to answer the main research question:

“How to efficiently implement an Information Management System integrated with the processes of the Quality Management System within a contractor and its projects?”

To structure the answering on this research question the conclusion is structured by the chapters of this report. The chapters results and discussion are combined.

Literature study
A Quality Management System (QMS) for the construction industry consists of the company and project processes with the goal to eliminate non-conformity to requirements, standards and customer expectations.

Information management in the construction industry is necessary to have the right information available for the right person in the organisation or during a project. Because of the large infrastructure projects with high amounts of information this can be a difficult task.

The biggest difference between the tender and realisation phase is the level of detail of the design; for the realisation phase a higher level of detail is necessary. Also, other processes are necessary for the realisation like completion and testing.

To structure the research 26 success factors for the implementation of an Information Management System integrated with the processes of the Quality Management System (IMS-QMS) are derived from literature. A survey, interviews and implementation plan have been executed according to these success factors.

Information management and Quality management Mobilis
The contract forms for the infrastructure construction industry mainly differ by the amount of responsibility for the contractor; the contractor is more involved during the design phase than decades ago. This means the contractor has to adapt with changing its processes.

The Quality Management System (QMS) and Information Management System (IMS) are integrated at Mobilis (and named IMT-MS) with the goal to realise successful project control according to the company’s quality plan where process management and information management go hand in hand and where the processes are explicit and transparent.

Results and Discussion
A survey has been conducted among users of IMT-MS of Mobilis to create an insight of the experiences of users and managers with this system. The survey is based on the 26 success factors derived in the literature study. Five interviews with the management director and department heads (managers and developers of the system) are conducted with the survey results as basis. The main results of the survey and interviews are:

- The group of respondents on the survey is small (35 persons), but consistent with sufficient leadership functions and more than half respondents from other companies than Mobilis.
- The goal of the new to be developed system is very important for the development and implementation. The goal should be clearly introduced in the company and in the projects.
- The influence of the management board, department heads and direct supervisors is important for the implementation; they should motivate the end user.
- The end user considers the training as not very important, but is a good tool to explain the end user what the goal of the system is, how the processes of the QMS are structured and what is possible in the system.
- The exchange of information is the most important for the system on communication level; the end user thinks the collaboration does not change much because of the system.
Increase Quality through Information Management

- Decision making is not sufficiently integrated in the system; this can aid (unexperienced) project managers with their decisions during projects.
- It is the ideal of the management board of Mobilis to have every department integrated in the system eventually, but the system should be implemented with projects first. Also the integration of clients and suppliers should be done later if the system is first fully functional and implemented in the organisation.
- The ease of use of the system is not sufficient, which doesn’t work motivating for the user. The speed and reliability is also insufficient, which should be improved to create confidence for usage of the system.

Implementation plan – organisation level

The implementation plan is written to answer the research question; the goal with the implementation plan is to efficiently implement a IMS with integrated QMS on organisation level and project level. Therefore the implementation plan is separated on these two levels. The implementation plan is written for a company that would like to adopt a new system regarding a IMS and QMS.

- Before a company should start with the development and implementation of a system like IMT-MS, considerations should be taken in mind if the system is right for the company. If the company is not right for the system or the system not for the company, there should not be started with development.
- The first step of development is to define the goal of the system within the company; it is useful to interlink the company goals with the system goals.
- The primary functions of the system are important to define, these should work sufficiently before implementing. Non-basic functions can be integrated and implemented later.
- The processes of the QMS have to be well implemented in the system to gain sufficient usage from the end user. The IT infrastructure should be adequately aligned with the company processes, but the processes should also be (re)designed to be adapted to the system.
- To create a motivated end user of the system, motivation is necessary from the different layers of management; the management board, department heads and direct supervisor. All management layers should motivate the end user, but department heads and direct supervisor should also directly motivate the end users.
- The main points that have to be explained at the first (short) explanation/training of the system are:
  - The goal of the new system
  - The processes of the company’s Quality Management System
  - Explanation how the system is structured.
- The training should be followed by intensive and accurate guidance from the support provider.
- One of the main functions is to improve the usage of the processes of the Quality Management System; by actively using the processes in the system the usage of the processes will improve.
- The ease of use is very important for the usage of a new system.
- It is important to keep the system reliable to create confidence with the system among the end user.

Implementation plan – project level

- Before starting a project with the system, considerations should be taken into account if the project is sufficiently aligned with the system. Also, a choice has to be made if there will be started with the system in the tender or realisation phase.
- The department heads and project managers play a crucial role in the implementation in projects; they should motivate the user.
- Because of the difference in detail design and processes used in the tender and realisation phase, the training should be adapted to these differences.
9. Recommendations

**General**

- Before starting with the development of a system, consider as a company if your company is ready for this development.
- During development keep in mind the eventual ‘ease of use’ of the system; this is very important for the motivation of the end user later in the implementation.
- Be selective with the involvement of the end user during development phase, but try to involve every end user during implementation phase.
- Take the differences of the tender and realisation phase in mind when giving training or explanation; the process and way of working is different and this should be addressed by a different training.
- Start with the implementation of a new system in your own organisation and have it sufficiently running before involving client or chain partners.
- Create a reliable system with sufficient speed and reliable connections otherwise the system will annoy users and users will not be motivated to use the system again.

**Mobilis**

- The survey held for this research can serve as a benchmark survey; the survey should be executed again after the new version of IMT-MS is 0.5-1 year implemented in projects. The differences between the results can be analysed to come to a better understanding of the opinion of the users.
- Have knowledge management in mind with the development of the system; this can be a useful and can increase the value of the system.
- Create a clear presentation or training for the implementation on organisation level, but also on project level with employees of other companies taken in mind.

**Further research**

- The research method including Success Factors can serve as a basis for further research on the topic or implementation of other systems.
- The construction industry is fairly unique, but it can prove to be useful to research if and how other industries integrate Quality Management with Information Management to compare it with the construction industry. On the other hand, research can be undertaken to look if IMT-MS can be used in other industries.
- BIM is currently a ‘hot topic’; lots of research has been executed on the topic and lots of (Dutch) companies are already using BIM or are implementing BIM now. Therefore research on the integration of the processes of a Quality Management System in a BIM system could be interesting to create better quality out of a BIM system.
References


Increase Quality through Information Management


Fisher, Norman; Yin, Shen Li (1992) Information management in a contractor – A model of the flow of project data


INCOSE (2013) www.incose.nl


Mobilis (2012) Beleidsverklaring 24-5-2012

Mobilis (2012a) Process of tender phase, 26-6-2012. Derived from company Quality Management System

Mobilis (2012b) Process of tender phase, 10-8-2012. Derived from company Quality Management System


O’Leary, D. (2008) Gartner’s hype cycle and information system research issues


