Added Value Through Agile Project Management During Early Project Phases in the Construction Industry

TU Delft

Witteveen + Bos

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Colophon

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Preface

Hereby I would like to present to you the final results of my graduation research completed over the past seven months, in order to conclude the master track Construction Management & Engineering (Delft University of Technology). During the master track my interests advanced in the two provided core subjects project management and process management. Throughout my studies, my curiosity grew towards the value of new project management methodologies. Through literary research I gained interest in the agile project management methodology. During classes we were used to learn about several methods and techniques, mostly based on conventional project management. Hence, for my graduation research I considered this to be an ultimate opportunity to explore a new project management methodology. Since the agile project management methodology is still relatively unknown in the construction industry, I wanted to determine how this methodology could be applied. Through a career day I came into contact with Witteveen+Bos, and was given the opportunity to further explore my interests at the Value Management department.

I would like to thank my graduation committee for their supervision and guidance during this graduation research. Completing the graduation thesis would not have been possible without them. I would like to thank Marcel Hertogh for helping me formulate my research clearly and always being aware of the bigger picture, as well as for all the constructive feedback. Also, I would like to thank Afshin Jalali Sohi for all of his time dedicated to helping me out on a weekly basis. Afshin has provided a lot of support and guidance throughout the development of the graduation research. Moreover, I would also like to thank Martijn Leijten for his guidance and his challenges to encourage myself to think outside of the box. His different perspectives on the research context opened new opportunities throughout the development of this graduation research. Lastly, I would also like to thank Ingrid Bolier for giving me the opportunity to perform my research at Witteveen+Bos and for giving me the freedom and guidance to define the context of the research to my own interests. She has supported and guided me throughout the development of the research.

Moreover, I would also like to thank all other the people who contributed to this research. A special thanks to all of the project managers who were willing to contribute to this research. The interview inputs and surveys were greatly valuable for my research. Lastly I would also like to thank everyone who provided their support for me during this graduation research. It was very valuable to have family, friends, and fellow graduates support me.

Enjoy reading!

Anne van Kralingen
Rotterdam, December 2017

Executive Summary

Introduction

Projects are becoming more complex and require a wide diversity of skills due to a change in the nature of projects and project environments. This has resulted in several obstacles in conventional forms of project management in the form of overruns. Due to high uncertainties and scope changes in projects, emphasis should increasingly be laid on the necessity of tailored project management methodologies. Evidently, project management methodologies should evolve in certain features in order more deliver more optimal value in present complex projects.

Increased insight into early project phases allows for a proper understanding of value generation, stronger involvement of all involved stakeholders, and thus ultimately an improved project execution. The agile project management methodology emphasizes flow and value generation in early project phases (Bruijn, Ten Heuvelhof, & In 't Veld, 2010). The methodology embraces changes and grasps them as opportunities to add value to deliverables and the overall project. Hence agile project management focuses more on value delivery of the project process, which could complement aspects of conventional project management methodologies. However as agile project management is currently merely applied in the construction industry, this research strives to firstly explore its applicability to infrastructure projects. Following, the added value of the methodology for infrastructure projects shall be determined.

For this reason the following research objective was obtained: *creating a model applicable in the construction industry presenting added value, in terms of project and process, of agile project management in early project phases in the construction industry.*

As the research objective states, this research aims to enrich existing knowledge about value management and agile project management in early project phases in the construction industry. Additionally, this research also aims to contribute to practice, since project managers in the construction industry are unsure of how to adapt this methodology properly. Hence, this aim has led to the following main research question:

> *What is the added value of agile project management during early project phases in the construction industry?*

In order to be able to provide a substantiated answer, several sub questions were developed in addition to the main research question. These sub questions will be provided in the introduction (section 1.7).

Reviewing

The scope of the research was limited to the overlap of the following aspects: early project phases, construction industry, agile project management, and value management. In the first phase of the research a literature review and exploratory interviews were completed to explore the scope. The aim of the literature review was to develop a basic understanding of the issues experienced in conventional early project phases. Moreover, as the agile project management methodology in the construction industry is explored to a limited extent, a thorough literature review was essential to investigate the current gap of applicability. Agile project management was explored regarding: principles, project characteristics, and methods. Moreover, the conventional and agile project management methodologies were compared in order to identify differences and opportunities. After exploring the current applicability of the agile project management methodology in the ICT industry, all of the elements were filtered according to their applicability to the construction industry. Hence a list of elements that could also be applicable in the construction industry was established. These elements were grouped into nine agile themed clusters, namely: (1) deliveries, (2) process, (3) planning, (4) teams, (5) project, (6) clients, (7) attitude, (8) documentation, and (9) location.

Besides a literature review devoted to agile project management, value management was also thoroughly explored. Value management was researched upon regarding two types of value, namely: project and process value. Research has shown that process value is merely acknowledged explicitly in literature for the construction industry. Literature acknowledged that value is defined in terms of benefits and in the context of measure criterion are translated to

performance criteria. Consequently, the criteria used for value management in terms of project and process was also based on performance criteria. For value of a project five criteria were established, namely: (1) cost of a project, (2) time of a project, (3) scope of a project, (4) quality of a project, and (5) clients and stakeholder satisfaction of a project. For process value twelve measurement criteria were established, namely: (1) scheduling, (2) clients and stakeholder satisfaction, (3) project teams, (4) budgeting, (5) performance information, (6) resources, (7) scope, (8) communication, (9) risk management, (10) quality, (11) attitudes, and (12) change management.

Apart from the literature review, exploratory interviews were completed in order to establish the company's role in early project phases. Moreover, through these interviews the researcher was able to develop an understanding of the company's perspective on value management in projects and processes as well as their familiarity with agile project management. The next step in preparing for the research phase was to compare the literature review with the outcomes of the exploratory interviews. Comparisons showed that the interpretations of early project phases are similar. Furthermore, the analysis of the exploratory interviews showed that value management measures are underdeveloped in an explicit sense in current practice, especially in terms of process. Notable was that when the respondents were asked to identify value they defined value in terms of clients and value for the company, and not in terms of projects and processes as literature recalled. Moreover, the comparison showed that agile project management is mostly unknown in current practice. Nonetheless the employees that were aware of the methodology only interpreted it in terms of stand up planning session meetings. Overall, interestingly the respondents agreed that the main value for projects is to satisfy the clients. Moreover they agreed that often in current practice reworks are necessary due to mistaken interpretations of expectations and products.

Results & Analysis

As difficulties were experienced in the acknowledgements of value management and agile project management in current practice, an extensive research methodology was applied in order to gain substantial reliable results. The research methodology can be broken down into three parts, namely: (1) case study research, (2) survey research, and (3) expert validation.

The case study research selection resulted in three dike projects, one bridge project, and one highway project. With the aim of gaining information on value management, problems and opportunities in current project management, four to five respondents were selected per project. The cross-case analysis for the five case studies led to a broad view on current value management, problems as well as opportunities in project management.

Problems Current Practice PM	Opportunities Current Practice PM
1. Difficulties in finding the right people for the project. 2. Often not enough time is spent together on location 3. Often the project team is not provided with proper documents. 4. Miscommunications, misinterpretations, and confusions are often caused by different language use within projects. 5. Schedules are often tight, making it almost impossible to follow it accordingly if changes occur. 6. The client is often more than one person. This can result in different opinions on deliverables. 7. Sometimes the client's involvement cannot be influenced if the client does not have the time to join team sessions. 8. Specialists often lack skills to communicate their good work appropriately to the client. 9. In case of holidays, scheduling is often too tight and not enough people are available.	1. Hire a team coach who focuses on training employees in more coherent communication, teamwork, and the correct attitudes within teams. 2. Make sure enough time is dedicated to getting to know each other. 3. Spend more time on continuously organizing sessions to update all team members. 4. Establish periodic audits also at team level 5. Make people aware of their responsibilities also for the bigger picture. 6. Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project. 7. Take more time to determine the project requirements and expectations together. 8. Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project.

As the results on value management from the case studies have stated, added value is achieved through adequate focus on a project process and by exceeding current expectations. Thus, the

problems and opportunities in project management were used to develop the model to compare to the results from the next step of the research. Moreover, the results have implied that obstacles in conventional project management methodologies could be minimized by focusing more on additional aspects within a project process such as communication and interfaces between teams.

The second research method applied was the survey research on the implementation of agile elements in current practice as well as value measures in projects and processes. For the value criteria, respondents were asked to indicate how each criterion performed in the project and process and whether they explicitly measured criteria. A total of eighty-seven respondents filled in the survey, which allowed for a correlation analysis between value in project and processes and the implementation of agile project management. Interestingly the results enhanced the opportunity of focusing on delivering value in the project process. The main results established that value and agile significantly correlated in terms of attitudes and teamwork in project processes. These results were then compared to the results from the cross-case analysis in order to establish added value of agile project management.

The results of the analysis of the cross-case analysis and the survey results together formed the list of added values as well as areas of attention. In order to guide project managers on how to achieve this added value of agile project management, a conceptual model was developed. This model was validated by an expert panel at the research company.

Conclusion

As the way value is currently defined and measured in literature and current practice is different than the value experienced when applying agile project management, the definitions were revisited. The definition of value for projects for a conventional project management approach focuses more on achieving the project aim within the costs and quality, whilst the agile inquires value more in the sense of high client and stakeholder involvement as well as short frequent sprints with feedback to timely enhance the expected scope. Hence the following definition for value in agile infrastructure projects was established:

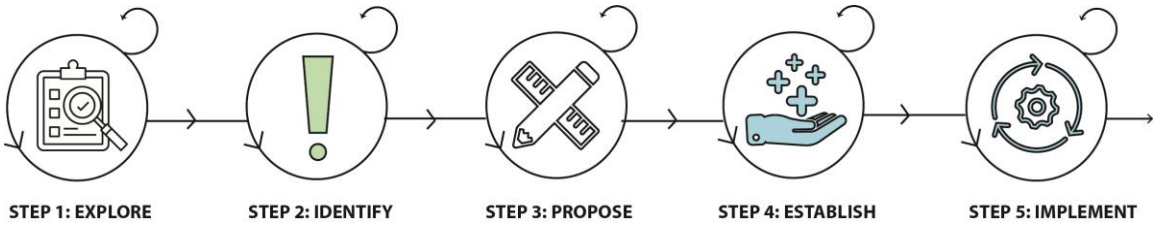
Value for agile infrastructure projects is directed towards focusing on continuously improving and frequent deliveries of products to clients and stakeholders, thereby timely satisfying the project scope.

The value for project processes is currently also defined differently than experienced through the implementation of agile project management in construction. Currently the definition refers to all of the activities between the beginning and end of a project and measures scheduling and budgeting, whilst the agile focuses more on the soft skills in processes to deliver value. Hence the following definition for agile infrastructure processes was developed:

Value for agile infrastructure processes is focused on teamwork and being able to continuously improve required deliverables throughout the project development. This is completed by adopting the correct attitude (ensuring employees trust and help each other) and by encouraging a good collaboration with clients and stakeholders.

Thereby this research can conclude that agile project management is related to value management, typically in terms of process value. Hence agile project management can be seen as an input for value management. Moreover, value management can be considered as an input for aspects of current project management. Hence the agile project management methodology is able to complement process aspects of conventional project management methodology. Nonetheless, a balance between the two methodologies is necessary to ensure that the strengths of aspects of project focus in conventional project management methodologies are not obstructed.

Moreover in order to conclude the research objective, the validated model was established. During a validation session organized at the research company, the conceptual model based on the research findings was discussed. The experts agreed that the model was applicable to the construction industry, however it needed some alterations in the implementation step and another additional step should be added to explore the project information upfront. This feedback was processed in order to develop the validated model as shown in detail in figure 21.



The figure displayed above, only highlights the main steps to be taken in order to implement agile project management in the early project phase of infrastructure projects and how this adds value. In the first step the project manager explores the tender. If the project encounters being a large complex infrastructure project with an uncertain scope, the model will be applicable. In the second step, the project manager will need to identify him or herself with the problems and opportunities experienced in current practices. If the project manager recognizes these statements, the agile project management methodology will be a suitable solution to implement. The third step of the model proposes preconditions in the form of agile construction principles that will need to be followed in order to apply the methodology. The fourth step then assures the project manager that the new tailored approach recognizes added value as well as certain areas of attention, which should be watched in order to abolish potential lost value. Lastly, the fifth step explains the project manager how to implement the scrum process for the project team as well as what the expected involvement of the clients are.

As the model explains, the fourth step of the model is able to answer the main research question, being: *What is the added value of agile project management during early project phases in the construction industry?*

The most important added values were established in the following agile element themes: process, project, attitude, location, teams and clients. Other added values that were recognized by several experts were planning and documentation. Regarding these themes added value was established in simplifying the project by breaking it up the into smaller do-able projects. This allows you to continuously have a strong focus and be able to deliver frequently and process changes timely. Moreover, added value was established in focusing on planning for the short-term period and revising the planning during weekly stands. This provides employees with awareness of the bigger picture and their responsibilities. Also, interim team evaluations and organizing set times to spread information and updates to the project teams is considered added value. Regarding teams, the aspect of focusing on evolving the project around motivated people that trust and help each other is considered added value. Lastly, minimizing documentation when applicable was also considered added value. However, this indicates that face-to-face communication methodologies should regularly be implemented to allow this.
Furthermore, added value for clients is found by viewing their collaboration to be highly important and including them in the project process regularly.

Recommendations

Overall, the main recommendations for the company derived from this research are to train employees to apply project management methodologies on a regular basis for an entire project. As currently several aspects of agile project management are already applied, however they are mostly applied sporadically. Hence to establish the added value as derived in this research, the methodologies should be applied continuously. Moreover through focusing on organizing interface sessions, teams will be provided with the bigger picture and could possibly enhance responsibilities and awareness more. Additionally, the client's expectations and requirements can be timely notified and more regular feedback can be established. This can also be completed by evaluating teams and products more often.

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List of Abbreviations

APM	Agile Project Management
BVP	Best Value Procurement
CI	Construction Industry
CPM	Conventional Project Management
DACE	Dutch Association of Cost and Value Engineers
HWBP	Hoogwaterbeschermingsprogramma
ICT	Information and Communication Technology
KMO	Kaiser-Meyer-Olkin test
KPI	Key Performance Indicator
PCA	Principal Component Analysis
PFU	Project Follow-Up
PMP	Project Management Plan
PSU	Project Start-Up
RWS	Rijkswaterstaat
VSM	Value Stream Mapping
W+B	Witteveen+Bos

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CHAPTER 1
Introduction

1. Introduction

In this introduction chapter different aspects that explain the research topic will be illustrated. Firstly the research context will be explained, followed by the problem description, the problem statement and the research scope. Also, the relevance of the research for the company where the research is being performed will be explained. Moreover, the research objective will revise why this research should be completed, followed by how the research will be completed in the form of research questions. Lastly, the research methodology and thesis outline will further explain how the research will be completed.

1.1 Research Context

Since the countless years that humankind has been involved in projects, the nature of projects and environments present day are increasingly changing in a continuous manner. Formerly, projects were considered simpler with outcomes that were anticipated to be more certain and only involving one or a few parties. Nowadays through this shift, modern projects suggest more complexity and the requirement of a wider diversity of skills (Nicholas & Steyn, 2012, p. 7). Subsequently, project management has grown in response to these needs. Approaches that deal with problems and opportunities in modern society are progressively being explored.

In order to understand why this graduation thesis topic extends current knowledge, the research context shall firstly enlighten why aspects of conventional project management should be developed in order to fit the complexity of modern projects. Additionally the context shall explain that more attention should be concentrated on early project phases followed by why collaboration and flexibility is necessary in current practice of project management approaches. The necessity for a more flexible approach will then be translated in the development of the agile project management methodology specifically for the construction industry.

Nowadays project failures in terms of cost and time overruns are considered to be a common practice, which has been investigated for years. These overruns are known to be a prominent issue experienced in conventional project management methodologies. One of the reasons for these overruns is the increasing complexity of projects as well as the underestimation of the project complexity (Bosch-Rekveldt, Jongkind, Mooi, Bakker, & Verbraeck, 2011). Particularly since the beginning of the 21st century, project complexity has been assumed to be the cause of lots of management problems in engineering projects (Hertogh & Bosch-Rekveldt, 2015, p. 123).

Several studies have revealed that improved insight into the early project phases allow for a better understanding of project value generation, stronger involvement, and thus followed by a better project execution. In early project phases little is known about the overall remaining project activities and execution in later project phases. Accordingly, ineffective focus and execution of the early project phases of projects can lead to undesired changes during later project phases (Kolltveit & Gronhaug, 2004).
Generally in a conventional project management environment less collaboration and feedback sessions are stimulated throughout the project. Thereby possibly increasing downside risks, especially if not enough time is spent on the early project phase. Also as for larger infrastructure projects numerous stakeholders will be involved. This will add to the uncertainty and possible downside risks as communication will be more difficult (Kolltveit & Gronhaug, 2004).

In essence the early project phase is meant to be about: preparation process of the future project phases. During this phase a clear scope for the project is defined in conventional project management methodologies (Hertogh & Bosch-Rekveldt, 2015, p. 123). For this reason, literature studies stress the importance and influence of early project development and state that attention should be raised for this phase in the project lifecycle. In this phase little has been decided upon, which leaves many options left open and implies that changes can easily be made with relatively little regret. Of course if too much time is spent on this phase, this might also result in unnecessary resources and could finally also lead to overruns in schedule or missed opportunities (i.e. in case competitors are able to deliver faster) (Rekveldt, Smith, Mooi, Bakker, & Verbraeck, 2011). Nonetheless, even when a lot of time is spent on early project phases, in general: as the project matures it becomes more difficult to make changes. In response to this, by adapting project management to become more collaborative and flexible, this could positively influence and respond to current issues being experienced in projects environments.

In order to be able to cope with complexity, uncertainty and other issues experienced during the process of project management, new forms of project management have evolved in recent years (Nicholas & Steyn, 2012, p. 7). Recent studies propose a change that is able to cope with these changing circumstances, and thereby being the opposite of early scope freeze, flexible and resilient projects (Priemus, Bosch-Rekveldt, & Giezen, 2013). A way to do this is by keeping options open as long as possible before developing parallel alternatives (Nicholas & Steyn, 2012, p. 7).

Constructive interaction can help projects to accept new changes, which can potentially improve project outputs, reduce costs or speed up the process of project deliveries (Hertogh & Bosch-Rekveldt, 2015, p. 120). This interaction should be realized in an adaptive environment, which will involve all kinds of stakeholders. The difference with conventional project management is that in the case of an adaptive environment, goals are not fixed, as the goals will also change as the context changes. Flexible project management anticipates this more, by focusing on satisfying needs through interaction in stakeholders' network, and also on the flexibility to have the ability to act in the face of changing circumstances or specific outcomes of management strategies (Hertogh & Bosch-Rekveldt, 2015, p. 113).

All of the above mentioned changes indicate that emphasis should be laid on the necessity of tailored management methods. Increasingly, as mentioned before, the conventional project management approach will always be able to satisfy project demands. Evidently, project management methodologies will need to evolve in some features that fit modern complex projects. Emphasis should be on projects that require being flexible and responsive, thus moving away from rigid planning and control (Koppenjan, Veeneman, van der Voort, Ten Heuvelhof, & Leijten, 2011). Literature argues that a paradigm shift is needed from the conventional project management concepts in order to deal certain future project management challenges and requirements (A; Jalali Sohi, Hertogh, Bosch-Rekveldt, & Blom, 2016).

Thus, the current construction industry is in need of exploratory research regarding new-born project management methods that respond to the gap explained above. There are different methodologies, tools, and techniques that help tackle the level of complexity currently found in the construction industry. A method that explicitly responds to the gap elaborated above, is the agile project management methodology. As the agile method is currently merely applied in this industry, an opportunity can be found in the deployment of this method (Koppenjan et al., 2011).
In contrast to conventional project management, agile project management discovers project requirements by carrying out the project in iterations, hence reducing and minimizing uncertainty. Because of this, agile tends to be of higher risk. However, as the focus of the methodology is on frequent interactions, this risk is again reduced. Moreover, the methodology has the flexibility to easily adjust to changes in project requirements (A; Jalali Sohi et al., 2016).

Even though there is a broad range of agile methodologies, all of the methodologies share the same main objective including small incremental deliverables that adapts to the most current information available, gets the customer involved as well as entrusting and empowering staff, encourages to never have breakage and have continuous question & answer sessions throughout the different project phases, as well as address risks as early in the process as possible in order to minimize the impact of changing requirements (Fernandez & Fernandez, 2008).
Thus, in theory agile project management is able to reduce substantive uncertainty as all the relevant information will be available to all involved parties right from the beginning of a project (Fernandez & Fernandez, 2008). As this allows parties to test the different sources of information against each other, this may improve the quality of information used and contribute to a positive start of the project, and consequently increase project value (R. Owen et al., 2006).

An additional issue that brought to attention and tackled by the agile project management methodology is the incorporation of dynamics. By doing so, one is able to evade parties the opportunity to distance themselves. Also by encouraging the incorporation of dynamics, this will lead to a process where parties are able to constantly improve and learn. Additionally they will constantly be faced with other parties and other or new views, which can stimulate them to reflect on their own views (Bruijn et al., 2010, p. 20).

Altogether an agile project management approach, is a comprehensive project management method with an underlying theoretical foundation that emphasizes flow and value generation (Bruijn et al., 2010, p. 22). As in preceding years the ICT industry has also had a poor record of delivering value and has consequently seized upon the recent evolution of agile project management, this triggers an opportunity for the development of this methodology in the construction industry (Fernandez & Fernandez, 2008).

Conventional project management practices for complex projects are dissatisfying in current project environments during early project phases in the construction industry.

1.2 Problem Description

As explained in the research context the issues of current project management practices lies within certain aspects of conventional approaches. The issues experienced in current practices call for a more collaborative- and flexible approach.

The current construction industry commencing towards developing methods and tools that respond to the current issues in early project phases and conventional project management. An possible opportunity to overcome these holdbacks is through the application of agile project management. As enlightened in the research context the application of this project management methodology, does have several limitations as the methodology has not yet been researched upon intensively. Nevertheless the lack of knowledge also creates an opportunity to explore this management methodology to a great extent and determine its applicability in the construction industry.

During the application of the agile methodology in the construction industry, the aim is to analyze how this influences value of a project as well as value of its' process, specifically in early project phases. In order to do so, a thorough literature study should be completed that firstly investigates the current gap of the applicability in the construction industry. Simultaneously value management shall be thoroughly explored in the context of project as well as the process applied that possibly stimulates added value. Regarding the value of agile project management, the question arises whether the project is able to respond to the initial inquiry and whether the process is able to stimulate added value in project activities.

A linear detailed project management methodology that unwelcomes changes is not satisfactory for current complex project environment necessities, as this often results insufficient value delivery to stakeholders as well as well-known overruns.

1.3 Problem Statement

Current practices of project management methodologies cannot always deliver optimal value. As aforementioned in the research context and problem description, this pledges for a need to move away from certain aspects of conventional project management. Exploring agile project management makes room for a more collaborative and flexible project management approach.

In addition to exploring the implementation of agile, the question arises whether this method is able to additionally deliver process and project value at a required level. In current practices, value management in terms of measuring value throughout the process of the project is missing knowledge. Therefore, it shall be vital to explore the value effect; both added and lost, of agile in order to conclude whether it positively responds to the existing issues experienced in conventional project methodologies.

In current complex project environments value is not delivered optimally, inquiring a methodology that enables optimized value delivery in both projects and project processes in the form of a more collaborative and flexible project management methodology.

1.4 Research Scope

In order to formulate a proper research question, the topic concerning the graduation thesis shall be broken down into a more specific research scope. This is due to the fact that only a research objective will be far too extensive to be dealt with in a single research project (Verschuren & Doorewaard, 2010, p. 18). From the previous sections, several key areas of interest have been isolated to form the project context. These four main topics that concern the research context can be found in the figure below.

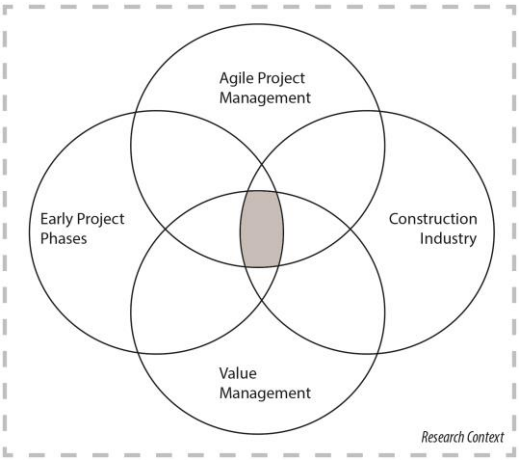


Figure 1: Research context

The grey area in the figure indicates that the research scope shall focus on the overlap between the early project phases, agile project management, construction industry, and value management. As agile project management is currently not adopted in the construction industry, it will be essential to compare the conventional project management approach with agile project management methodology and identify the differences and opportunities. Additionally, the way in which agile project management is currently being adopted in the ICT industry should be evaluated. This will allow the research to adopt elements of agile that will also be applicable to the construction industry.

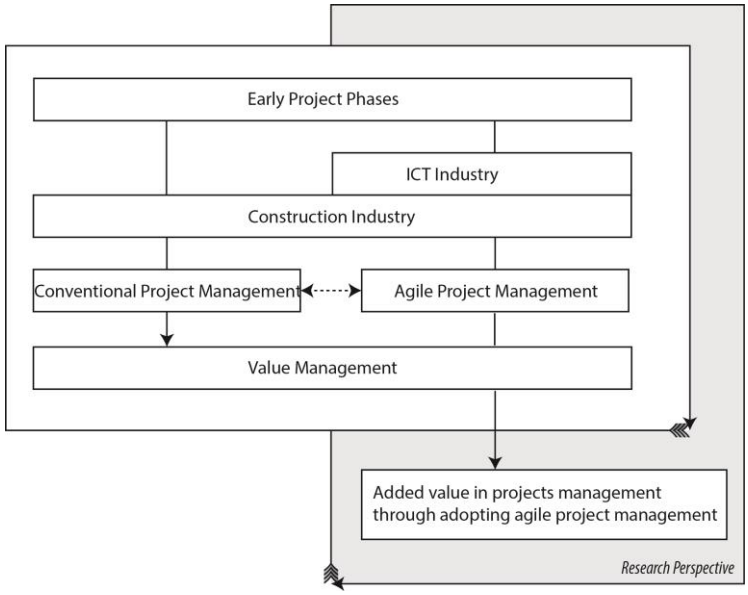


Figure 2: Detailed scope and research perspective

Following the comparison, value management within these management methodologies should be evaluated in order to be able to discuss how agile project management is able to add more value to early project phases, as mentioned in the grey area in the research perspective figure.

1.5 Research Relevance Company

This research will be completed at the department of Value Management at Witteveen+Bos. At this department everyone considers it to be very important to always consider the value of all activities you are about to engage in as well as the value of an activity after having completed it. As the agile project management methodology is focused on frequent interactions and continuously improving, it will be an interesting methodology for the department to consider.

During the first weeks at the company, no concrete agile project management practices could be found in projects. However, after some exploratory interviews, it became clearer that the agile methodology was slowly and desultory being applied in some projects.

Through experience employees have indicated to be unaware of the methodology and elements needed to apply in order to engage in the methodology. Thus it will be interesting to attend project meetings and interview employees on current practices. This practical research shall reveal whether people are possibly already unconsciously applying agile methodologies. Additionally this research can discover what employees are experiencing as unpleasant and if these issues can actually be minimized through the application of agile project management. Either way, it will be noteworthy to scrutinize how this ICT project management methodology can be applied in the construction industry and also in a way that it is able to add value. Consequently through this research the company will be explained how they are able to optimize their early project phases through agile project management methodologies and when (if) they should still apply a conventional methodology.

Furthermore the company supervisor, Ingrid Bolier, is involved in DACE – a knowledge platform for value management in the Netherlands. Approximately fifteen different people from different companies are involved in the core strategic decisions on value management for the Netherlands, which take place every three months. As different companies are involved in this platform a broad perspective of value management in the construction industry can be explored. Additionally it might be possible to also include a case study from one of the other companies to compare or broaden the reliability of the outcome on value of agile project management. Consequently this will also make the final outcomes of the research more meaningful for Witteveen+Bos, as the results will have come from a broader range of experiences.

1.6 Research Objective

Based on the research context and the problem description, the main objective of the research thesis can be formulated. As the agile project management methodology is unexplored in the construction industry, firstly the methodology will need to be translated to this industry in order to establish its possibilities. In order to then be able to apply the methodology and evaluate on the added value, a model will be created. Thus, the main objective is formulated in the box below.

A model applicable in the construction industry presenting added value, in terms of project and process, of agile project management in early project phases in the construction industry.

1.7 Research Question

In response to the research objective, a main research question has been formulated that will act as the nature of the research thesis:

What is the added value of agile project management during early project phases in the construction industry?

To be able to answer the main research question, the following sub-questions shall structure the research:

1. What is agile project management? And what are the differences with conventional project management styles?
2. How can value in projects be measured?
3. How can value of project management processes be measured?

4. Which aspects in project processes are currently are and are not delivering optimal value?
5. How can value be optimized in these processes when applying an agile project management methodology, and lead to project value?
6. What is the value when applying agile project management methodology?

1.8 Research Methodology

The research will be split up into four main phases. The first phase will elaborate on the applicability of agile project management in the construction industry through a literature review. Additionally value management in projects and processes will be researched upon. Alongside the literature review, exploratory interviews will be organized. In the next phase, the research will be conducted through case study interviews and surveys. The next phase will then analyze the gathered data and develop a conceptual model for added value of agile project management. The model will then be evaluated and validated. Finally, the last phase will provide a final discussion on the model, limitations and recommendations of the research.

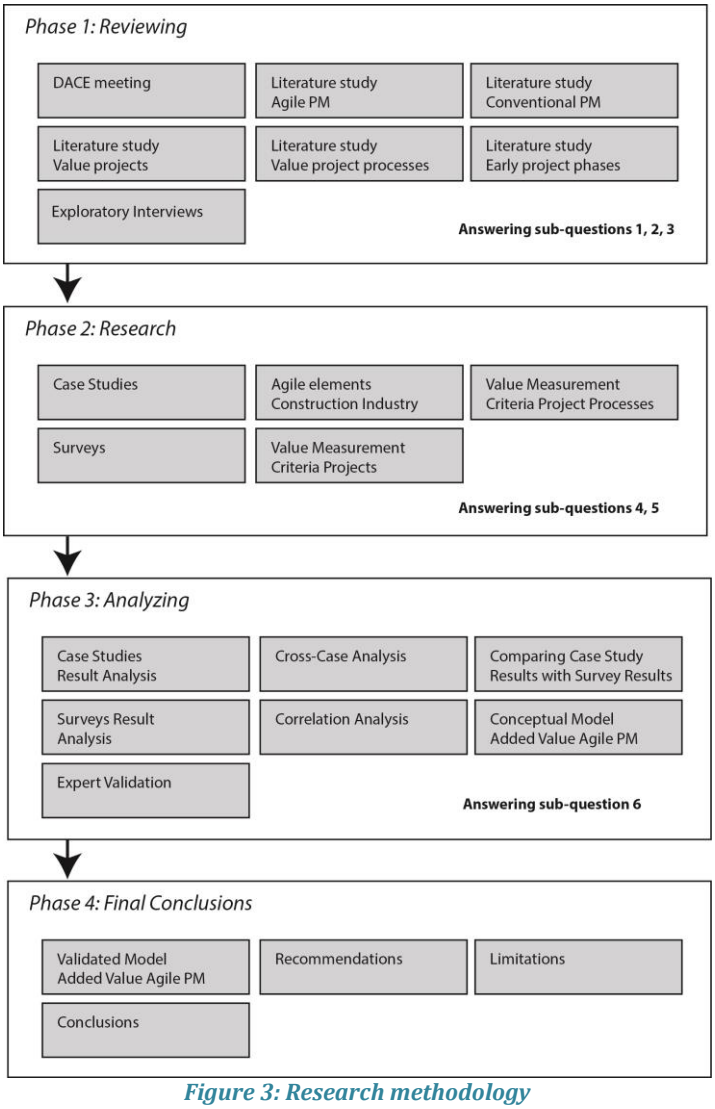


Figure 3: Research methodology

During the first phase of the research, a literature review shall be conducted along with exploratory interviews in order to understand in what way agile project management is currently already being applied, as well as how value is currently being measured. Furthermore, during the first DACE meeting, a survey will be provided. The survey will allow the researcher to develop an understanding in the current value management practices and awareness of agile project management methodology in the construction industry. It will be interesting to see how different companies are possibly experiencing agile project management as well as how they are measuring value. In this way, possible additional case studies could be conducted. The

exploratory interviews within the company will be conducted in a semi-structured sense. This form of interviewing has been chosen as this allows people to brainstorm and provide their own initiatives (Songer & Molenaar, 1997). Especially as current literature lacks agile in the construction as well as process value measurement criteria, it will be interesting to prepare open questions.
Moreover, the literature study shall explore agile project management in its provided values, principles, methods, characteristics, and common practices. The outcome of the study shall be translated into elements. These elements shall then be filtered to applicability to the construction industry. Next, the elements shall be categorized into main themes, which will form the basis for the revised principles and following research.
The literature study shall also explore value management. In current literature, no specific distinction is made between the value measurements of project and processes. The two are related, but must be revised separately in order to fully understand the value a project management methodology can present. Thus, for both projects and project processes, criteria will be established. These criteria will be linked to measurement techniques for both agile and conventional methodologies. In this way, during the interviews for the case studies the current practices can be revised, as people will be able to enlighten which methods they are currently applying in order to measure value in their projects and processes.
Having completed this, the first three sub-questions will be answered. Through literature it will be clear what the differences are between conventional project management and agile project management. Likewise, the literature together with a combination of the exploratory interviews will clarify how projects and project processes can be measured.

During the next phase, the proposed agile principles for the construction industry will be explored through case study interviews with employees in the field of project management. To make the final outcome more interesting, case studies with the company as well as with a combination of another company will be included in the research. For each case study, 4-5 employees will be interviewed in a structured manner.
Additionally, surveys will be conducted to develop a broader viewpoint on the implementation of the agile elements as discovered in the literature study as well as value performance and measures in current practice in terms of projects and project processes.

In the following phase, these results will be analyzed. Firstly each case study will be analyzed individually, followed by a cross-case analysis. The survey results will be analyzed through a correlation analysis according to the themes as established in the literature review. Comparing these two outcomes will provide the problems and opportunities in current practices as well as added value through agile project management. Moreover, areas of attention will also be discussed. These results will be translated into a conceptual model, which will then be validated through experts.

Furthermore, in the last phase of the research, the validated model will be discussed, along with the general conclusions of the research. Moreover, the sub-questions and main research question will be answered. Also, recommendations for further research and for the company will be provided, and limitations.

1.9 Thesis Outline

The thesis report will be outlined as shown in the next figure. The thesis report will consist of seven main chapters, spread throughout the four phases as stated in the research methodology.

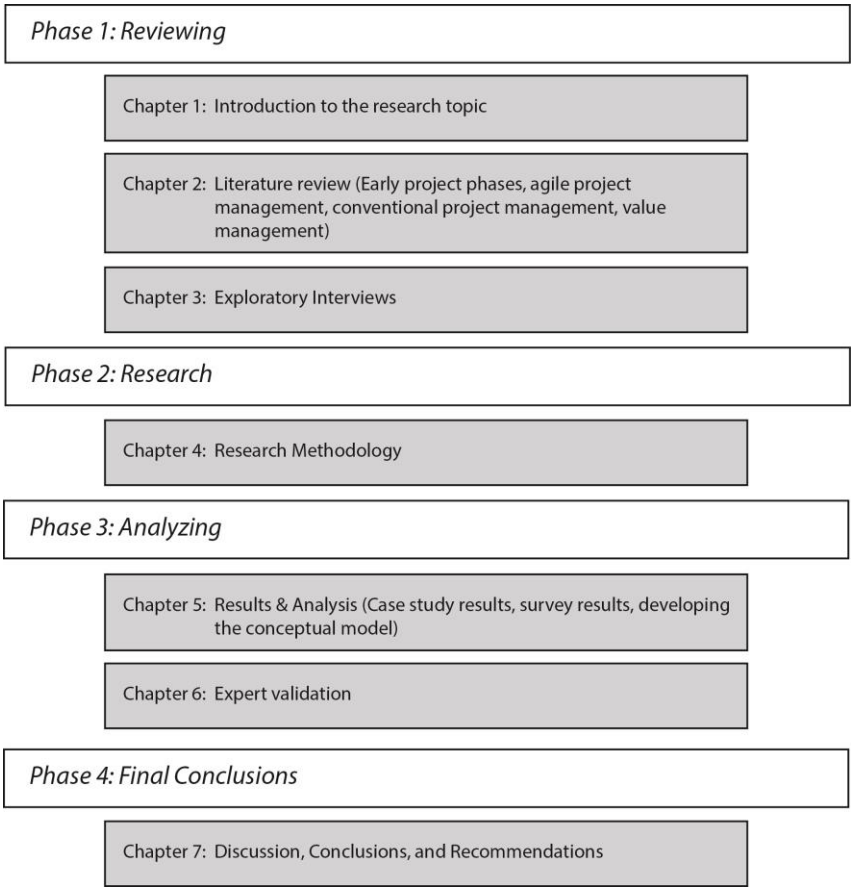


Figure 4: Thesis outline

CHAPTER 2
Literature Review

2. Literature Review

This chapter shall entail the literature review as introduced in the previous chapter. The aim of this chapter is to develop a basic understanding of the issues in the early project phases, which seek a different project management approach for particular aspects. Also, this section will elaborate on the differences between conventional and agile project management and research upon which agile elements can potentially be implemented in the construction industry. In order to establish added value of the project management methodology, a literature review will also be performed on value management. The study of literature on value will be completed in terms of value for projects and processes as well as how value can be measured.

2.1 Importance of Early Project Phases

In order to analyze the added value of the agile project management methodology in the early project phase, firstly the phase will need to be defined. In general for complex projects literature states that the early project phase has a duration of up to a year (Xia & Lee, 2005). Throughout the early project phase, typically different activities occur for different projects due to their uniqueness. Nonetheless in general, the phase exists of two main sub-phases being initiation and planning (Cox, 2010). These two phases can again be broken down into other sub-phases. Overall some of the activities belonging to the early project phases are: the project aim is identified, client requirements, the kick-off meeting, project team organization, planning, set of alternatives, and preferred decision (Bosch-Rekveldt, 2011; Gibson, Wang, Cho, & Pappas, 2006; Heagney, 2016).

Regarding overall project phases, overruns in the forms of cost and time delays are not uncommon in the construction industry (Bosch-Rekveldt et al., 2011; Koppenjan et al., 2011). As has been stressed throughout literature for several years, there is a lack of attention is for the importance of early project phases (Fernandez & Fernandez, 2008). Articles have stated that particularly in early project phases a lot of effort should be put in defining value, as this phase is the basis for all the remaining phases of a project. If value is not correctly identified in an early project phase, this will have a consequence in later project phases (Kolltveit & Gronhaug, 2004).

By improving insight into a projects' early phases, one can develop a better understanding of project value generation, stronger industrial involvement, and improved decisions (Kolltveit & Gronhaug, 2004). As during early project phases very little is known about the project activities and execution, a lot of uncertainty exists. In addition to the uncertainty, high potential influence for stakeholders exists as the details for the following phases has not yet been set and the involved costs are still low for making changes. This reasoning suggests that the early project phase is a very important phase for determining activities and planning the project execution that also identify and realize value (Kolltveit & Gronhaug, 2004).

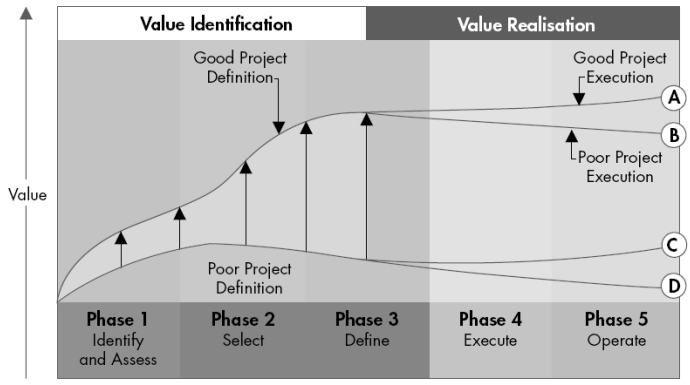


Figure 5: Influence of early project phases on value development (Constantinos, 1984)

If the early project phase is executed ineffectively, especially in major projects, this can lead to unforeseen changes during later execution phases (R. Owen et al., 2006). This can increase the downside risk of the project. Literature has stated that often in practice the approach of an early project phase tends to be either too programmatic or too chaotic. This can then result in incomplete, inconsistent, or otherwise suboptimal guidance during later project phases (R. Owen et al., 2006).

As projects are increasingly becoming very complex, it is essential to understand the project complexity in a different way for certain aspects than conventional project management. By adopting a different project management methodology, this can potentially decrease current observed overruns. Hence, decoupling the natural engineering desire of the 'predict and control' approach and suggesting a management methodology that does not exclusively following this approach. Instead include a more process oriented 'prepare and commit' strand is the proposition for aspects of conventional project management that initiate the need of a different project environment (Bruijn et al., 2010).

As indicated, a new movement should be made within project management in order to cope with complexity and demand for change for particular projects. This movement does not indicate that focus of project complexity must be laid on the reduction of complexity, instead focus on an approach that responds to change quickly without major consequences. Agile project management offers potential in the early project phases as this methodology focuses on an iterative and incremental development, facilitating innovative solutions – particularly for complex projects and uncertain requirements (Bosch-Rekveldt et al., 2011).

Agile project management potentially assists the ineffective execution during early project phases and generates value from an early stage of the project. This can also be viewed in figure 5. Reasoning for potential success of the application of agile project management in early project phases is due to the success in the ICT industry. The importance of the early project phase with high uncertainty projects has several similarities with the construction industry (A.; Jalali Sohi, Hertogh, & Bosch-Rekveldt, 2016). This will be explored in the remainder of this chapter.

2.2 Identification of Conventional Project Management

The conventional project management methodology emerged in the 1950's in the defense and aerospace industry that was known to have little flexibility and complexity at the time (A; Jalali Sohi et al., 2016). As suggested in the research context, recent studies opt the need for a more tailored project management method for complex projects in the construction industry.
In the development of project management methodologies several conceptual approaches can be observed (A.; Jalali Sohi et al., 2016). The traditional project management approach is also generally referred to as the 'plan-driven' approach (Buresh, 2008; Jalali & Wohlin, 2012; Moe, Dingsoyr, & Dyba, 2010). As there are many more different management approaches referred to in literature, the term conventional project management will be applied throughout this research. The conventional project management approach includes many different methods, all plan-driven, among which the well-known waterfall method also belongs. In this approach one usually moves through a series of well-defined steps from requirements to execution and completion (Buresh, 2008).

Conventional project management, is known for its very disciplined and deliberate planning and control methods where tasks are completed one after another in a predefined order (Moe et al., 2010). This requires a significant amount of planning to be completed up front, which can be seen as a downside as projects are rarely able to follow the sequential flow. Additionally, clients usually find it difficult to completely state all requirements early on in a project (Hass, 2007).

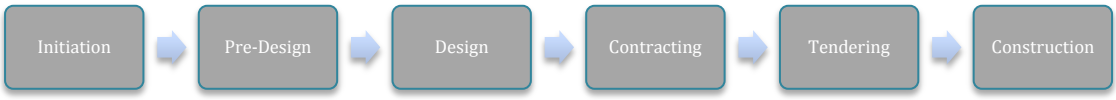


Figure 6: Waterfall life-cycle model (McLaughlin, 2017)

Generally in conventional project management one is concerned with topics such as scheduling, cost control and work breakdown structures (Bosch-Rekveldt, 2011). Planning fundamentals are essential and are completed precisely from the beginning till the end, often at the start of a project. There are two essential phases in project management that can be identified: the conception and definition phase. During these phases a plan is prepared and during the execution phase a plan is performed (Nicholas & Steyn, 2012). The main tool that is used to define the work that needs to be done is the work breakdown structure, and for the process scheduling a Gantt

chart that uses the critical path method. A more detailed discussion about these two methodologies is provided in Appendix A1.

Project Characteristics Infrastructure and ICT

To understand the type of projects in the construction industry a list of characteristics have been concluded from literature. The general project team size of infrastructure projects during an early project phases up to a year is thirty-four team members. For these infrastructure projects, many different stakeholders can be involved, this depends on the type of project (T. M. Williams, 1999; Xia & Lee, 2005). In general for complex projects this involves the clients, the project manager, public authorities, owners and surrounding residents.

Specifically to the construction industry, the following characteristics can be summed up for large infrastructure projects (Boehm & Turner, 2004; J. Lin, Er-shi, & Bo, 2014; Lui, Lou, Shen, & Wu, 2006; Songer & Molenaar, 1997):

- Well-defined scope/goal
- Established budget (tremendous amounts)
- Long-term projects (long periods)
- Established completion date (and starting)
- Standard design specifications
- Non-recurrence
- Uniqueness
- Often underestimated risks
- Network of internal and external interested parties with a stake in the project
- Resistant to change
- Many different stakeholders
- Large project teams

Table 1: Characteristics large infrastructure projects

In a later phase of the literature review, a comparison will be made between agile and conventional project management (section 2.4). In addition to this list, characteristics from the ICT industry should also be considered to provide an indication of the type of projects and their overlap. Thus, taking into consideration the conventional project management approach from the software industry, several general characteristics, which are also applicable to other industries, are (Peterse & Wohlin, 2010):

- The desired functions need to be specified beforehand
- A detailed plan is constructed from the start till the end of the project
- Requirements are specified in detail
- Architecture and design specifications have to be complete before execution starts

Table 2: Overlapping characteristics ICT industry conventional project management

The overlapping characteristics indicate that similarities exist between the ICT and construction industries. For example in conventional sense both types of projects predefine their scope thoroughly. For both types of projects numerous issues (mostly in terms or scope, time, cost and budget) have been distinguished over the years, jointly confirming that conventional project management does not always fit the complex and changing character of projects. Consequently, as projects continuously growing bigger and more complex, these issues for overruns are also growing (Flyvbjerg, 2007).

Another example of an issue in conventional approaches can be found in the management of large scopes. Often regular interactions between parties are limited, making it difficult to enable the same understanding of the scope for each project member. Project members tend to focus only on the part of the process in which they are involved as they are only involved in the bigger picture of the project during milestone meetings (Buresh, 2008). Moreover, customer interaction in conventional approaches is limited generally to providing the requirements in the beginning of the project and feedback towards the end (Peterse & Wohlin, 2010). Literature has identified several causes for the lack of customer involvement, being: skepticism and hype, the distance

factor, lack of time commitment, dealing with large customers, fixed-bid contracts and ineffective customer representatives (Hoda, Noble, & Marshall, 2011).

Problems Experienced in Large Infrastructure Projects

In order to evaluate where possible opportunities for different project management methodologies lie, an overview of issues experienced collected in literature for large infrastructure projects will be provided below (Flyvbjerg, 2007; Howell & Koskela, 2000; Locatelli, Brookes, & Invernizzi, 2017; Pollack, 2007):

- Risky and long planning horizons
- Complex interfaces
- Decision-making and planning are often multi-actor processes
- Conflicting interests
- Project scope will often change significantly over time
- Unplanned events that are unaccounted for, leave budget contingencies sorely inadequate
- Misinformation about costs, benefits and risks due to changes
- Cost overruns and/or benefit shortfalls for the majority of projects
- Projects often lack good communication with stakeholders outside of the project team
- Difficulties in communication (interpretations, miscommunications)
- After the goal is defined, it will likely change in the project
- Uncertainties as to scope and methods are high due to changes
- Activities are often interdependent (affect each other)
- Team members often complete work with little regard for how it might affect others (the bigger picture)

Table 3: Problems experienced in large infrastructure projects

An example for overcoming some of the problems such as communication and complex interfaces is improved collaboration. As stated in the research context this can help projects to accept new changes, which can potentially improve project outputs, reduce costs or speed up the process of project delivery (Hertogh & Bosch-Rekveldt, 2015, p. 120). Improved collaboration should be realized in an adaptive environment, which will involve all kinds of stakeholders and who have the desire to explore the room for changes and flexibility within projects (Olsson, 2005). A methodology that realizes this desire is the agile project management methodology, originating from the ICT industry. This methodology is largely unknown in the construction industry, thus the following section will elaborate on this methodology. The section shall discuss the applicability of the methodology to the construction industry.

2.3 Agile Project Management

The agile methodology introduced in the ICT industry in 2001. In the ICT industry the needs of client(s) in terms of functions and quality kept constantly evolving, which led to high requirement volatility. This resulted in ICT companies to need to become more flexible (Boehm & Turner, 2004; Petersen & Wohlin, 2008). Hence, the agile methodology is a response to the need to modernize project management (Bosch-Rekveldt, 2011). The term agile itself is a collective term for many methodologies that aim to increase the relevance, quality, flexibility, and business value of software solutions (A.; Jalali Sohi et al., 2016).

The following main issues for ICT projects were collected in literature in projects that encountered that resulted in the application of agile project management (Boehm & Turner, 2004):

- Incomplete requirements
- Low customer involvement
- Lack of resources
- Unrealistic expectations
- Changes in the requirements
- Lack of planning
- Useless requirements

Table 4: Problems experienced in ICT projects

Defining agile project management

In order to be able to understand the technique and review its applicability as well as added value to the construction industry, one will first have to understand the philosophy behind agility. Accordingly, three relevant definitions have been provided below that will form the final definition to be used throughout the thesis, from an ICT industry point of view.

> *"Agile Project Management is a style of project management that focuses on early delivery of business value, continuous improvement of the project's product and processes, scope flexibility, team input, and delivering well-tested products that reflect customer need."*
> *(R. Owen, Koskela, Henrich, & Codinhoto, 2006)*

> *"Agile Project Management is an iterative process focused on the continuous monitoring and improvement of deliverables. At its core, high quality deliverables are a result of providing customer value, team interactions and adapting to current business circumstances."*
> *(Layton, 2010)*

> *"Agile Project Management is an iterative process that focuses on customer value first, team interaction over tasks, and adapting to current business reality rather than following a prescribed plan."*
> *(Nath, 2015)*

The important key terms have been underlined in the definitions above. From these definitions the terms that have been repeated at least twice are: customer value, adapting to the current, iterative process, and team interactions. Thus using these key terms, the following definition can be formulated:

> *"Agile Project Management is an **iterative** process that is able to **continuously improve** deliverables through increased collaboration and flexibility ensuing increased **customer value** in projects."*

As the above definition enlightens, the main idea behind the agile project management methodology is allowing change even in later project phases as it can be transformed into added value for the customer. Currently only two main criteria are defined as far as value for the customer, being: the scope of the project, and a corresponding planning (A.; Jalali Sohi et al., 2016).

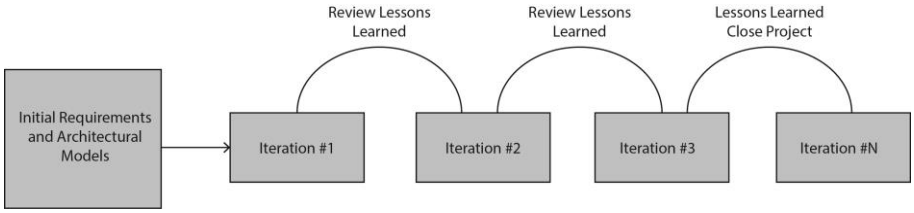


Figure 7: Lifecycle approach agile project management (Hass, 2007)

As one will be able to see in the figure above, the life cycle of an agile project management methodology is different in comparison to a conventional approach as the project process consists of many small parts of the project in the form of an iterative approach. Thereby

encouraging collaboration, knowledge sharing and accurate control over the project process, as planning and requirements are constantly revised.

Value in agile project management

As mentioned in the section about early project phases, also in conventional construction project management methodologies this phase is considered extremely important for value identification and generation. As this phase is the basis for the following subsequent phases, the output should be comprehensive, integrated, as well as consistent (R. Owen et al., 2006). Using the agile project management methodology, the identification and generation is continuously reviewed and adapted to keep meeting requirements.

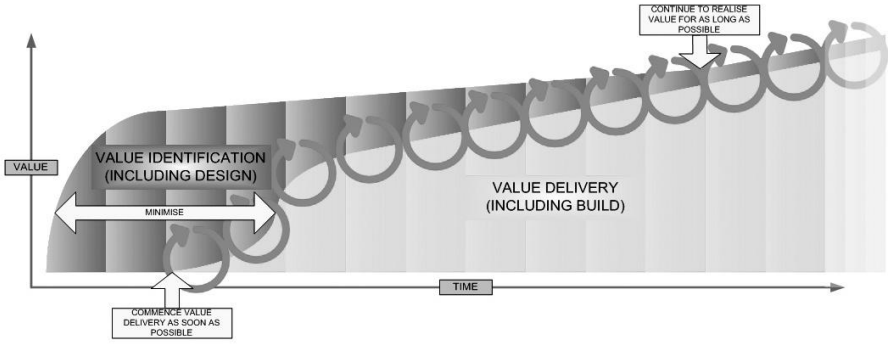


Figure 8: Value in an agile project process (R. Owen et al., 2006)

As the figure shows, a major focus of agile project management is early delivery of value that is sustained. At the end of iterations value must be delivered. As indicated by Owen (2006), at the end of each timebox the value is recognized in terms of feedback and learning. This is essential for the realization of customer value (R. Owen et al., 2006).

Comparing this value figure to a conventional approach, the value of the project and process are agreed upon between the developer/contractor and the customer(s). The agreement is based on when the customer is prepared to accept the project as complete (R. Owen et al., 2006). For the agile project management methodology value is identified in small parts and delivered more frequently to the client(s) to encourage feedback.

Applicability of Agile Project Management in Construction

Although several indicators suggest that agile principles shall also be applicable to non-software projects, current research regarding agile is limited to the field of the ICT industry. In this industry, agile project management has become a prominent methodology which has added significant value to projects (Hobbs & Petit, 2017b).
In a very broad sense, both the ICT and construction industries are of essence a design and product development process with limited tailored re-uses of design and component (Pressman, 2009).

First suggestions of agile use in the construction industry dates back to 1999 with intentions to apply the methodology in supply chains. Since then however there is still not a clear implementation methodology of the agile project management technique. Recognized in literature is that the methodology exemplifies visibility and active responsiveness (Mostafa, Nicholas, & Abdelhamid, 2016). In highly unpredictable environments such as projects in the construction industry, visibility of decisions, risks and requirements are extremely important. The original scope and risks identified of projects often change and are not always responded to properly. Introducing a methodology that enables intense collaboration and encourages flexibility can potentially minimize current issues.

Aforementioned, issues are often traced back to an occurrence in the early project phase. As the agile principles and tools for ICT states: its employment promises potential for an improved approach for the early project phase, being simultaneously appropriately structured but also flexible enough to allow opportunities to be seized and creative solutions to be devised (R. L. Owen & Koskela, 2006). This mind-set and process approach is also applicable to the construction industry and could potentially add value to projects as well as project processes.

Additionally by delivering small elements of the final product frequently and evaluating each delivery, the expectations of the client can be lived up to more realistically. Issues in construction projects have stated that the project is often well defined up front but not properly revised throughout the process to encounter misinterpretations and changes. This could be minimized when applying agile project management through the more frequent smaller deliveries. Hence, less rework will have to be done throughout the process.

2.3.1 ICT Agile Manifesto

In 2001, out of frustration of multiple practitioners the 'Manifesto for Agile Software Development' was established in order to manage projects in chaotic settings (R. L. Owen & Koskela, 2006). The manifesto enlightens certain values that are applicable to all agile projects as well as principles.

The manifesto indicates underlying principles that must be fulfilled in agile project management. The principles emphasize concentration on early and regular delivery of value, and the use of changes as opportunities to enhance value. The agile principles are a set of twelve (Alashqur, 2016; Beck et al., 2001; Boehm & Turner, 2004; Shirvastava & Rathod, 2015; Tilk, 2016) guiding concepts that support agile project teams in implementing agile and staying on track. Important to keep in mind is that these principles are set out for ICT projects, and not specifically the construction industry.

1. Highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even in late development.
3. Deliver working software frequently.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. Face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity – the art of maximizing the amount of work not done – is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become effective, then tunes and adjusts its behavior accordingly.

Table 5: Agile ICT principles

In order to understand which of these ICT principles will also be applicable to the construction industry a combination of literature and current practices will be explored. The literature review will elaborate on which elements will be applicable to the construction industry, and the following chapters will research these elements in current practice.

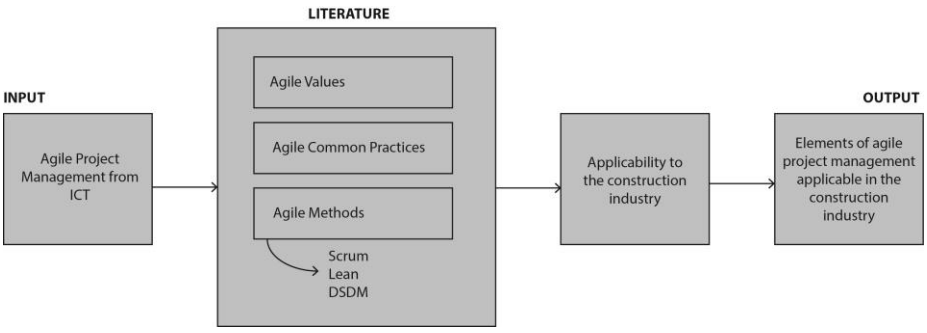


Figure 9: Literature review output agile for construction

The following sections of the literature review will elaborate on these ICT principles in terms of values recognized in the manifesto; characteristics and activities apply for agile projects, and

methods. All of these agile elements will be filtered to possibly be applicable to the construction industry and will then be used as input for the research of current practices. A list of these elements can be found in table 13.

2.3.2 ICT agile values

The Agile Manifesto acknowledges four main values that are applicable to the ICT industry. The main values are comparisons between conventional and agile projects, namely (Alashqur, 2016; Beck et al., 2001; Serrador & Pinto, 2015; Vinekar, Slinkman, & Nerur, 2006):

- Individuals and interactions are more valuable than processes and tools
- Delivering a high-quality working system is a higher priority than producing comprehensive documentation
- Customer collaboration is more important than the fulfillment of predetermined requirements specified in a contract
- Responding to change is preferred to attempting to cope with change through extensive planning

Table 6: ICT agile values

As stated, instead of a conventional approach a major goal is the incorporation of customer input to ensure proper delivery of projects, as well as satisfying involved parties throughout the development cycle. Agile methodologies enable facilitation of better communication and feedback due to small iterations and customer interaction. Additionally all involved parties must be on-site as this encourages frequent feedback (Peterse & Wohlin, 2010).

Agile Project Characteristics and Activities

In addition to the values, project characteristics and activities should be examined. Cross-referencing will be applied to determine the most essential characteristics and activities (Appendix A2 illustrates the full table). By developing an understanding of agile project characteristics allows the researcher to analyze which characteristics could be applied for infrastructure projects. The cross-referencing of literature has allowed the researcher to combine and narrow down the extensive list to several essential activities. Whilst filtering the activities, the typical activities specific to the ICT industry (unit testing, code refactoring) as well as the activities that have only been mentioned once have been left out. Reasoning for leaving out specific activities and characteristics is to develop a list of activities actively recognized that could hypothetically also be applied in the construction industry. These activities have been summarized in the table below. These activities shall be used for the final list of agile elements to be explored further on in the research.

Frequency	Agile Activity/Project Characteristic
5	Feedback sessions and reviewing to continuously improve (Q&A)
5	Retrospectives
5	Iterations
4	Frequent face-to-face communication
4	Sprint planning (small releases)
4	High customer involvement on-site
4	Adaptable projects (change management)
3	People-oriented
3	Collaborative development (helping each other)
3	Cross-functional teams
3	Simplicity in designs
3	Self-management of teams (small teams)
3	Re-prioritizing requirements and activities
3	Frequent deliveries in short iterations
2	Evolutionary development
2	Minimizing documentation
2	Incremental approach

Table 7: Frequently recognized agile project characteristics and activities

2.3.3 Methods for agile project management

In order to apply agile project management is will be necessary to explore the methodologies needed to apply the methodology. Firstly, the general methods applicable to the ICT industry will be illustrated, followed by a study on which methods have previously also been recognized in the construction industry.

When only taking into consideration literature in reference to the ICT industry, the commonly used tools are: extreme programming, scrum, crystal and feature driven development (See Appendix A3 for the complete table). Generally the main agile methods all share the same concepts and areas of focus. However, to ensure that all detail of each of the methods is taken into account for the development of the agile elements for construction, all methods will be researched upon for their applicability in the construction industry.

Agile Methods	Characteristics	Possible applicability to the construction industry	Recognized in CI?
Extreme Programming (1)(2)(3)(8)	Created to help small teams to develop software when requirements vague and change frequently. It features frequent releases in short development cycles, coding in pairs, and unit testing of all code (4) (5) (6) Main techniques are: whole team, planning game, small releases, acceptance tests (11)	Whole Team method, which requires intensive teamwork and on-site collaboration. Also open workspaces (pair programming) is an opportunity for collaboration (5) (8)	-
Scrum (1)(2)(3)(8)(12)	Process framework to deliver products with the highest possible value and handle complex situations. Main techniques are: daily stand-ups, sprint planning and product backlogs. (4) (8)	Daily stand-ups, sprint-planning and product backlog can change the current nature of planning (5) (9) (10)	Yes (9)
Crystal (1)(2)(3)(8)	Family of methodologies to allow the organization to select one of the methodologies as the appropriate through color-coding. Focuses on teamwork, communication, frequent reflections (4) (6) (7)	Seat people close together for them to communicate frequently and with goodwill. (5) Color-coding risks could also be an option.	-
Feature-Driven Development (FFD) (1)(2)(3)(8)	Method proposed to affect only the design and building phases. It has a great concern about quality of the process and frequent deliveries along the time (4)	Emphasize on quality through breaking the process up into features (10)	-
Lean Development (8)(2)	Activities that do not add value to the customer are considered waste (4)	Identifying the value stream, optimize operations and manage value generation (12) (13) (14)	Yes (13)(14)
Adaptive Software Development (ASD) (8)(1)(3)	Solves issues in large and complex systems development. The method tries to avoid projects failure (4)	-	-
Dynamic Systems Development Method (DSDM) (8)(2)(3)	Assumes project flow should be based on the amount of resources and time to develop features should be predefined. Main techniques are time-boxing, MoScoW rules, and prototyping (4) (9)	Time-boxing, a fixed period of time and at the end the objective must be met (10)	Yes (9)

1 (Zhi-gen, Quan, & Xi, 2009) 2 (Conboy & Fitzgerald, 2010) 3 (Vinekar et al., 2006) 1 (Campanelli & Parreiras, 2015) 2 (R. Owen et al., 2006) 3 (Tilk, 2016) 4 (Cockburn, 2004) 5 (Bohner & Coram, 2005) 6 (R. L. Owen & Koskela, 2006) 7 (Boehm & Turner, 2004) 8 (Lindstrom & Jeffries, 2004) 9 (Bertelsen & Koskela, 2004) 10 (Bertelsen, 2002) 11 (Bryde, Demir, Fearon, & Ochieng, 2012) 12 (Bass, 2016)

Table 8: Agile methods applicable in the construction industry

As the agile methods Scrum, Lean Development and Dynamic Systems Development Method are the only methods recognized in construction literature, these methods will mainly be researched

upon. Appendix A3 explains the scrum methodology, lean development and dynamic systems development method in-depth. The section below will only summarize the methods.

Scrum
Scrum focuses on collaboration, self-management of teams and flexibility in order to attain an adaptable attitude (Tilk, 2016). The methodology acknowledges three roles: a product owner, the development team and a scrum master. A product owner represents the customer(s) involved in the project and is accountable for ensuring the value of the project output (Cervone, 2011). The development team generally consists of six to nine members across different disciplines. Each team focuses on a part of the final product. The team is generally self-organized and chooses themselves how best to accomplish their work. The third role, the scrum master, is responsible for ensuring that the scrum team adheres to the scrum theory, practices and rules (Schwaber & Sutherland, 2016). This role will be completed by a project manager or a team leader (Cervone, 2011).

The process of scrum is known to have five major activities: the kick-off, the sprint planning meeting, the sprint, the daily scrum, and the sprint review (Cervone, 2011). The changing character of the product in accordance to the customer(s) and team, as aimed for when applying scrum is achieved by working in short cycles called sprints. A sprint will lead to higher quality and higher customer satisfaction as the cycle provides a higher predictability for the customer and thus also influences customer satisfaction (A.; Jalali Sohi et al., 2016). Each sprint will approximately take up two to four weeks.

Lean Development
Lean development is a variant to scrum and consists of a start-up, steady state or renewal project phases (Tilk, 2016). This methodology focuses on implementing a more efficient approach where possible wastes are eliminated (Boehm & Turner, 2004).

The methodology has established principles regarding value, value stream, flow, pull, and perfection. The principles can again be translated into nine tools, which are used to identify non-value-added project phases and production steps. The purpose of the tools is to increase capacity, improve throughput, reduce cycle time and eliminate waste (Westcott, 2014).

Dynamic Systems Development Method
This methodology focuses on choices to be made when time constrains apply. Nine principles form the methodology as well as two main core techniques, namely: Timeboxing and MoSCoW. Timeboxing is comparable to milestone planning and MoSCoW to prioritizing in the project planning.

#	**Agile Activity/Method Characteristic**
1	Time is fixed
2	Reprioritizing of activities
3	Cross-functional teams
4	Many small teams
5	On-site
6	Daily stand ups
7	2-4 week sprints
8	Timeboxing
9	Scrum retrospectives
10	Transparency
11	Trust
12	Openness
13	Scrum board
14	Product backlog
15	Burn down chart
16	Short innovative brainstorm sessions
17	Visualizing activities
18	Eliminating activities with less priority
19	Team empowerment

20	Focus on frequent delivery
21	Collaborative approach
22	Prioritizing activities
23	Prioritizing requirements
24	Color-coding themes
25	Open workspaces

Table 9: Agile elements from agile methods and activities

Altogether characteristics and activities mentioned in the scrum, lean development, dynamic systems development method, and possible extra aspects taken from the other methods are listed below. These will be used for the final agile elements that will be implemented in the research (Section 2.6).

2.3.4 Strengths & Weaknesses of Agile Project Management

In order to be able to discuss how agile project management adds value, the strengths and weaknesses of the methodology will be explored. Several strengths can be established that suggest why this methodology should be used, as displayed in table 10.

(Shubh & Gandhi, 2012)	**(Hobbs & Petit, 2017b)**	**(Johansson, 2012)**	**(Balaji & Sundararajan Murugaiyan, 2012)**	**(Bass, 2016)**	**(Hobbs & Petit, 2017a)**
Early benefits to the user/business	Faster multiple deliveries of functionalities	-	Rapid delivery of useful functionalities	-	Rapid delivery to customers
-	Improved identification of needs and priorities	Better defining of the clients' needs	-	Client is highly involved	Improved satisfaction client
Regular trade-off discussions	-	-	No guesswork, as there is face-to-face communication	Required to share regularly to avoid duplication	Improved communication
-	-	Decreases uncertainty	-	Reduced risk due to incremental delivery	-
-	Rapid adaption to change	-	Ability to adapt; respond to change	-	-
-	-	Increased participation of the client	-	Frequent feedback from the client	-
-	Supports creativity and production	-	-	-	-
Elimination of inherent schedule flaws	-	-	-	-	-
-	-	Improves risk management	-	-	-
Conflicting requirements breakdown	-	-	-	-	-
-	-	-	-	-	Comprehensive documentation, less misinterpretations

Table 10: Advantages agile project management

Through cross-referencing, the researcher was able to establish that early deliveries to customers are an advantage. Additionally, through including the client frequently, the project team will be able to improve the identification of the client's needs and priorities. Also, regular face-to-face meetings encourage a proper and improved form communication, when compared to conventional project management.

In addition to the many possible advantages agile proposes, several downsides can also be discovered. However, there is a lack of literature describing projects where agile methods failed to produce good results. There are only studies that have reported poor projects due to negligent implementation of agile methodologies (Daneva et al., 2013). The disadvantages are by the ICT industry and there is a lack of agile practice in the construction industry, it is still indefinite as to which weaknesses could apply to the construction industry

(Kaufman & Rodriguez, 2015)	**(Boehm & Turner, 2004, 2005)**	**(Petersen & Wohlin, 2008)**	**(Hobbs & Petit, 2017a)**
Not enough employees with agile experience	Lack of highly qualified team members	Team members must be highly qualified	-
General resistance to change	Willingness to change attitude	-	-
-	Long-term commitment for projects	On-site commitment for the entire process	-
Management support	-	-	Management support
Ability to change organizational culture	-	-	Difficulty in committing to agile project parameters
-	Required co-location, customer access	-	-
-	-	Continuous testing/feedback requires much effort	-
-	-	-	Higher operating costs
-	-	-	Immediate delivery can lead to short term view need rework for future more complex features

Table 11: Weaknesses of agile project management

Thus the downsides discussed are based on propositions and on not fully implementing the agile approach accurately. A weakness can be discovered in the teams proposed by the agile methodology as they imply the need for members to be highly qualified. Also, in regard to parties being on-site, this also requires everyone involved to commit for the whole process, generally meaning a considerable period (Peterse & Wohlin, 2010). Also, this technique might not be practical as there might not be any space to temporarily house all involved parties (Shubh & Gandhi, 2012). Another downside is that neither culture nor the mind-set of people can be changed easily, which makes it difficult to move to agile methodologies (Moe et al., 2010). Furthermore, a possible downside of agile methodologies is that heavy interactions could possible become too high maintenance. Moreover, as the amount of people involved grows it will increasingly become difficult to coordinate the teams (Shubh & Gandhi, 2012).

Overall the limited literature states that agile project management methodologies could definitely offer considerable potential in the construction industry, especially in regards to the predesign and design phase (R. Owen et al., 2006). Hurdles could be experienced during the implementation, however literature suggests that organizations can overcome hurdles with diligence, patience and work (Boehm & Turner, 2005).

2.4 Differences Between Conventional- and Agile Project Management

As the research context has explained, several aspects of conventional project management require a different approach in order to deal with particular complex projects that continuously change. By identifying the differences between the two methodologies, the researcher will be able to establish which elements of agile project management can potentially improve aspects of conventional project management.

"Agile project management methodologies promise higher customer satisfaction, lower defect rates, faster development times and a solution to rapidly changing requirements. Conventional project management approaches promise predictability, stability, and high assurance" (Boehm & Turner, 2003)

In terms of change, a difference that can be established between the two methodologies is that conventional attempts to minimize change in the project process through gathering requirements upfront, analysis, and design. Through the gathering upfront the conventional approach intents to attain higher quality results under a controlled schedule. In contrary to this approach, agile methodologies assume that change in the project process is not only inevitable, but also necessary, and aim at achieving innovation through individual initiative (Vinekar et al., 2006). Also, in opposition of the conventional approach, requirements are revisited continually (Shubh & Gandhi, 2012).

When looking at the type of activities and priorities in both product life cycle models, the figure below shows a comparison. From a waterfall project to an agile project the emphasis changes from delivery to a specification within a timescale and budget, to delivering emergent value within similar constraints. Agile methodologies often control scope through the use of value prioritization techniques. Examples are: You Aren't Going to Need It (YAGNI), Must have, Should have, Could have (MoSCoW) – which have been mentioned in the above section on agile methodologies (Hass, 2007).

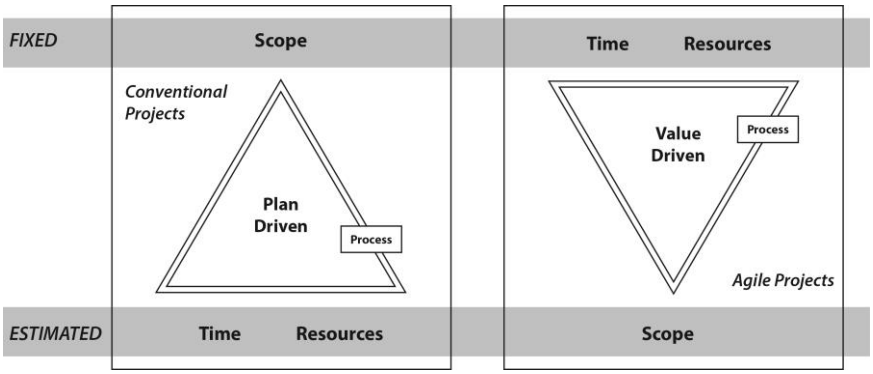


Figure 10: Comparing project management processes (R. L. Owen & Koskela, 2006)

The only downside to this illustration is that in the construction industry resources are unlikely to remain fixed if the scope is changed (R. L. Owen & Koskela, 2006).

To summarize the literature review on the differences between the two methodologies, the table below shows the differences between the two management methodologies. The conventional project management methodology is mostly currently applied in infrastructure projects and the agile project management methodology illustrates characteristics of ICT projects.

	Conventional Project Management	**Agile Project Management**
Team Composition [3, 5, 7]	Larger teams, role separation	Small teams, team decisions, co-located
Process [4, 7]	Linear, beginning and end predefined	Iterative (not delivering all at once)
Project Environment [3, 4, 6, 7]	Simple design, Low-change, stable	Complex, flexible attitude to change, adaptive
Requirements [1, 2, 4, 7]	Well-understood, clear initially	Emerging, customer included to verify, innovative

Cost [1, 6]	Deliverable-based, high-rework costs, estimated	Time-based, low-rework costs, fixed
Scope [1, 4, 6]	Well-defined, fixed	Incremental (in several cycles to complete), undefined at the start
Schedule [6, 2]	Estimated, Sequential long term planning, prepared in detail for the entire project, rigidly followed	Fixed, Focused on realistic short term planning, decision delayed until 'last responsible moment'
Management coordination [1, 4, 5, 6]	Hierarchal, Managerial decision-making	Self-managing, Collaborative work
Customer relations [3, 5, 7]	Low involvement, interactions when needed	High involvement, dedicated and on-site
Location [3, 4]	Everyone is spread, separate offices	Co-located teams including the customer
Project Development [4]	Extensive design, long increments	Simple design, short increments
Life Cycle [4, 6]	Focus on optimizing over a longer period	Focus on immediate delivery of functionality
Skills [4, 5]	Specialized skills	Multidisciplinary skills
Documentation [4, 7]	Formal documentation required, detailed project plans	Tacit knowledge, comprehensive documentation
Evaluations [4, 6]	End the project status report, milestone date phases reports (project outcome focus)	Feedback sessions, retrospectives, post iteration
Communication [5]	Formal, written status reports	Face-to-face, frequent, openness of information exchange
Team Member contribution [5]	Individual tasks, share information/progress during milestone meetings	Cross-functional team thus expected all team members contribute – daily meetings help the team balance

1 (Meyer, 2016) 2 (R. L. Owen & Koskela, 2006) 3 (Boehm & Turner, 2003) 4 (Boehm & Turner, 2005) 5 (Lindsjorn, Sjoberg, Dingsoy, Bergersen, & Dyba, 2016) 6 (Parente, 2015) 7 (Spundak, 2014)

Table 12: Differences conventional and agile project management

Overall when taking the negatives and positives of both project management methodologies into consideration, the main conclusions that can be drawn are that agile enhances certain abilities related to flexible project management better than conventional methods. The agile methodology recognizes the inevitability of change and that project management should incorporate the change factor in order to be able to achieve value for the client(s).

Evaluating throughout the project process is not completed regularly in conventional project management. Hence issues in the relation with the client and within teams are recognized only at the end of a project. When adopting agile project management methodologies evaluations will be introduced during the process. The methodology recognizes that evaluations improves learning throughout the process and stimulates an improved relationship both internally and externally.

Another difference between the two methodologies is that early and frequent small deliveries are unfamiliar in current practices of infrastructure projects. Nonetheless problems in current practices state that often well-defined scopes that have been established at the start of a project changes over time. This results in a lot of rework that must be completed towards the end of the project causing significant overruns often recognized in terms of cost and time. This can hinder the value of the project.

Moreover agile project management recognizes that smaller deliveries minimize uncertainties over the course of a project. The methodology initiates smaller deliveries, as they are easier to adjust. Also the deliveries are made simpler, however still with clear goals. In current practice of infrastructure projects, goals are also defined upfront however for a long course of the project instead of for each smaller delivery separately. Moreover the clarity of goals and requirements are often not visible in the same manner for the entire team.

Additionally, agile recognizes the importance of value for the client(s), and states this should be central, along with collaboration and working on-site. For current practices of infrastructure projects, employees and customers often work off-site at separate offices. Thereby implying that a different form of communication is necessary to work together. For the agile project management methodology face-to-face communication is always implied when possible, as this stimulates the openness of information exchange.

Lastly in terms of team composition, differences between the two methodologies can also be established. Conventional project management teams often consist of larger teams with a clear role separation. For agile project management the teams are often smaller and decisions are made on a team basis instead of a individually. Moreover, teams are cross-functional consist of self-management disciplines. Thereby the teams have more multidisciplinary skills instead of more specialized, as often recognized in conventional project management.

2.5 Hybrid Agile Project Management

In previous sections the differences, ad- and disadvantages of agile project management have been stated. As there is a lack of research, concrete conclusions of implementation of agile project management cannot currently be made. Thus different options will need to be considered. As certain construction project characteristics might not be able to change, the research will also need to establish alternatives that implement the compulsory components of infrastructure projects as well as provide room for the agile project management methodology. The combination of conventional and agile is referred to as hybrid. The figure below illustrates the combination of the two forms of project management.

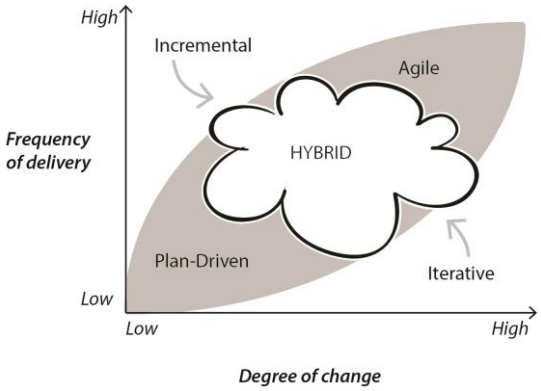


Figure 11: Hybrid agile project management (Fewell, 2016)

The conventional project management methodology is referred to as the plan-driven approach in this figure, and agile is found on the top right of the figure. By combing both and finding appropriate solutions that ultimately satisfy and improve current practice, is in this case met through hybrid project management. Additionally, as it will not be possible to transition from a conventional project management to agile project management straight away within a day this methodology also creates room for a transition period.

Hence the hybrid methodology could possibly be the combination that will be applicable to the construction industry. Hybrid agile project management can be applicable to high-risk projects as iterative techniques can be used to ensure drawbacks and opportunities are revealed on time. For these types of projects, incremental techniques could help navigate in complex environments and ensure a more accurate on-time delivery (Fewell, 2016). The flexibility of an agile approach should be balanced with the advantage of a more traditional approach through a risk-based analysis (Boehm & Turner, 2004; Hobbs & Petit, 2017b).

2.6 Agile Elements to be explored in the Construction Industry

The main elements that were discussed in the literature review were based on agile values, agile methods, agile principles as well as agile common practices. In this section these elements will be sorted into themes. The themes and elements will then be analyzed during the case studies and surveys.

In the value and project characteristics and activities sections of the literature study, the elements were filtered and all the specific ICT elements were eliminated.
Each element has been assigned a number. This will allow the researcher to organize all the elements in the following this table section. The extensive list of the agile elements and numbers can be found in Appendix A5. The table below will only illustrate the final themes and elements related to them.

#	**Element**	**Agile Theme Clusters**
18	Time is fixed	Delivery
33	Burn down chart	
50, 14	Deliver frequently	
53	Constant pace	
25	2-4 week sprints	
26	Timeboxing	
49	Early and continuous delivery of valuable projects	
3, 5, 14	Iterative, short	Process
5, 45, 15	Evolutionary Development, continuous improvement	
26	Timeboxing	
27	Scrum retrospectives	
38	Focus on frequent delivery	
17	Incremental approach	
7	Adaptable	Planning
19, 13	Reprioritizing activities	
19, 40, 41	Prioritizing, Reprioritizing activities	
47	Change is welcome	
1	Review sessions	
24	Daily stands ups	
31	Scrum board	
32	Product backlog	
35	Visualizing activities	
36	Eliminating activities with less priority	
42	Color-coding themes	
5	Sprint planning	
9	Team mindset	Teams
21,12	Many small teams	
22,12	Self-management of teams	
4, 46	Face-to-face communication	
1	Review sessions	
20, 10	Cross-functional teams	
8	People oriented	
24	Daily stand ups	
27	Scrum retrospectives	
24	Daily stand ups	
37	Team empowerment	
45	People interaction	
55	Self-organized teams	
23	On-site	
48, 11	Simplicity	Project
47	Change is welcome	
45	Continuous improvement	
54	Technical excellence and good design	
7	Adaptable	
5	Small releases (project components)	
23, 6	On-site	Clients
13, 46	Face-to-face communication	
6	High involvement	
1	Review sessions	
2	Retrospectives	

40	Prioritizing activities	
27	Scrum retrospectives	
34	Short innovative brainstorm sessions	
39	Collaborative approach	
29	Trust	Attitude/Communication
30	Openness	
28	Transparency	
2	Retrospectives	
8	People-oriented	
47	Change is welcome	
4, 46	Face-to-face communication	
51	Motivated people	
16	Minimal documentation	Documentation
31	Scrum board	
32	Product backlog	
35	Visualizing activities	
23, 6	On-site	Location
43	Open workspaces	
44	People interaction	
42	Color-coding themes	

Table 13: Literature elements sorted into themed clusters

As one will be able to observe, the table includes nine themes regarding the different elements. These themes and elements will be explored in the research analysis chapter when analyzing the case study and survey results.

Answering Sub-Question 1
The definition of agile project management states that the methodology is significantly recognized for its iterative process, which stimulates continuous improvement and frequent small deliveries through active collaboration. As a result increased customer value of projects is recognized in the ICT industry. The agile methodology encounters 12 principles that act as a guiding concept throughout projects. Additionally four main ICT values of agile project management have been established that identify the main benefits of the methodology compared to a conventional project management approach. Moreover, in order to implement agile project management, several methods have been established.

Conventional and agile project management differs in quite a few aspects. Both methodologies have advantages and disadvantages in particular aspects. For example, extensive documentation as applied in the construction industry can also be an advantage when something goes wrong in a project and nobody knows who is to blame. Additionally, as employees in the construction industry often do not work on one project only, they will have a lot of variety in their work locations compared to always working on-site with the project team on one project at a time as proposed for agile project management.

Defining and constantly redefining the client(s) needs is often neglected in current practice of construction projects. Contrary, for agile this is very important. Additionally the relation with the client is valued highly and the client is involved as often as possible and also works on-site. These characteristics of the client(s) position in a project are currently not properly recognized in infrastructure projects.
Also, the construction industry is known to be resistant to change. By being resistant to change, opportunities can also be missed which later on in the project cause rework. Instead agile project management focuses on smaller parts of a project at a time and is open to changes within these iterations.
Moreover another difference in team composition can be noticed. Conventional project management methodologies tend to have larger teams with a clear role separation, whilst agile stimulates smaller cross-functional teams.

Likely conventional project management will not be able to adapt agile project management immediately, a transition period referred to, as hybrid might be applicable. Another reason for hybrid could be if certain aspects from construction projects will remain compulsory even when implementing agile.

2.7 Value Management

As all articles regarding agile project management state, the methodology is aimed to deliver continuous as well as early value. Therefore, the past paragraphs have researched upon this methodology, however as value is one of the key drivers of agile, a separate section will be devoted to how value can be measured. Value will be considered in terms of project and processes. Thereby, once having translated the agile principles, one will be able to analyze how the methodology responds to value in positive or negative form in the construction industry.

"Value management derives its power from being a team-based, process driven methodology using function analysis to examine and deliver a product, service or project at optimum whole life performance and cost without detriment to quality" (Male et al., 2007).

Lawrence D. Miles at General Electric (GE) first developed the value management methodology in the late 40's (Aigbavboa & Oke, 2017; Thiry, 2014). The methodology was introduced in order to examine alternative materials for the purpose of selecting the one that provided the same, better, or best function at the least cost. The form of value management implemented at that time is now known as hard value management. Miles based his concept of value management on three main principles:

- The concept of functions to define a product by its functionality rather than its technical characteristics - The use of multi-disciplinary teams in order to develop well-balanced and comprehensive solutions - The application of a structured job plan based on the sequential use of creativity and analysis

Table 14: Hard value management principles in the late 40's (Aigbavboa & Oke, 2017)

In later years as these principles were translated to hard criteria, and soft value management was also developed. The soft criteria focus more on achieving stakeholders' needs and expectations (Thiry, 2014).

The value management methodology was further developed in the early sixties by Charles Bytheway by introducing a Function Analysis System Technique (FAST) diagram (Thiry, 2014). Another development for value management is referred to as SMART. The method focuses on improved in decision-making techniques, from brainstorming to such principles as simple multi-attribute rating techniques. Additionally focus on customer satisfaction and application of other management principles such as lean construction and customer quality management have formed the value management methodology (Aigbavboa & Oke, 2017). The value management organization tasked with the responsibilities of regulating value and value management practices in the Netherlands is called the Dutch Association of Cost Engineers, Special Interest Group Value Management, established in 1984 (DACE, 2017).

As Chase states, an innovative environment requires two different types of value, being: product (the end of a project) and process value. Process value is largely untouched in literature, even though it is just as important as the product value (Chase, 2001). Process and project value do not always have to be correlated, as a good process does not have to mean that all project objectives have been met.

Value Management will be researched upon in the project sense as well as the process. As there are no mandatory set of tools or techniques that set standards to measure value, it will be important to research upon this matter in order to conclude whether agile project management creates a different value in comparison to the conventional plan-driven methodologies.

Performance and value measurement criteria

Measuring value is done through measuring the benefits of a project. This can be done in emotion and rational manners (Lever, 2017). However actually demonstrable value measures in project management is often only simply discussed. Defining the value in project management is considered to be difficult, let alone measuring it. As value is defined by project benefits, this is translated to measuring project performance (Cheng, Tsai, & Lai, 2009; G. Lin & Shen, 2007; Thomas & Mullaly, 2007). Thus value management of project management is reviewed and measured with performance measurements literature. Thereby researching upon the value of the project.

Other literature states that in measuring value, you are trying to demonstrate that decisions made have indeed added value to the project. Therefore you are measuring performance measures, and these measures are translated into value. Thereby making performance measures the same as value measures (CBP, 2005; Patah & de Carvalho, 2007). Throughout this study there will also be significant overlap with performance measures. As literature has stated that these measures are considered to be the same and measure the same, this pronunciation will also be applied in this research.

2.7.1 Defining Value Management for a Project

In order to be able to define how value can be measured in projects, it will also be important to understand how projects are defined, as projects are projects are currently defined in a conventional project management sense. The project management institute defined a project as:

"A project is a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and end. Unique means that the product or service is different in some distinguishing way from all similar products or services"
(Duncan, 1996)

However, as recent graduate has stated that this definition should be revised for current projects. Her revised version of a project definition states:

"A project is a temporary endeavor undertaken to achieve a value oriented overarching goal which involves multiple value streams. The project may end when other projects provide more value"
(Verbruggen, 2017)

Taken into consideration the value management aspect for current projects when implementing agile project management methodologies, this definition should still be shaped into a specific agile construction project definition. Nonetheless, these definitions will guide the start of the research on measurement of value for projects.

In engineering, a main objective is to create additional value (Chase, 2001). In order to add value, it will be necessary to understand how value is interpreted in terms of projects. In accordance to value of projects, different definitions of value management that have the focus on project value are provided below. These definitions will act as a guidance of the definition that shall be used throughout the thesis.

A structured means for achieving better business decisions, which can be supported by all stakeholders; improved products and services; enhanced competitiveness by facilitating innovation
(Thiry, 2014)

"Value Management is the name given to a service in which the sponsor of a project, the client, transmits a clear statement of the value requirements of that project to the project designers."
(ThoughtWorks, 2017)

"A disciplined procedure directed towards the achievement of necessary function for minimum cost without detriment to quality, reliability, performance or delivery"
(Green, 1994)

"Value Management derives its power from being a team-based, process driven methodology using function analysis to examine and deliver a product, service or project at optimum whole life performance and cost without detriment to quality"
(Male, Kelly, Gronqvist, & Graham, 2007)

The important key terms have been underlined in the definitions above. From these definitions the terms that have been repeated at least twice are: client, quality, performance, delivery, cost. These terms have formulated the following definition for value of projects displayed below.

*"Value Management in terms of a **project** is directed towards the delivery of a product or a service to clients and stakeholders at an optimum quality and performance as well as at an acceptable cost and schedule."*

2.7.2 Measuring Value of a Project

In order to conclude whether a project has added value or created lost value, it will be important to research upon the ways in which value can be measured for projects. As the definition above insinuates, the iron triangle seems to be most important in measuring value of projects. In order

to ensure that these measurement criteria are still appropriate, a cross reference of value project management measurement criteria has been completed in the table below.

(Atkinson, 1999; de Wit, 1988; Mokoena, Pretorius, & van Wyngaard, 2013)	(Stenlund, 2010, p. 71)	(Pennypacker, 2005, p. 5)	(NederlandseNormalisatie-Instituut., 2011)	(McArthur, Zerjav, & Edkins, 2017)
Cost	Budget	Project budget	Expenditure incurred on	Cost
Time	Schedule	Project scheduling	Timescale	Time
Scope	Meeting client needs	Project requirements	Scope	Purpose
Quality	Quality	Quality	-	Quality
Customer satisfaction	-	Customer satisfaction	Satisfaction of customer needs	-
-	-	-	Consumption of resources	-
-	Place	-	-	-
-	-	Learning and growth measures	-	-
-	-	-	Performance index	-
-	-	-	-	Process Interactions

Table 15: Overview value measurements for projects

Through time, literature has evolved and has started to move away from the traditional iron triangle where the people factor has not been included. Current literature emphasizes the importance of the people involved and their capabilities and commitment as well as satisfaction (Baratta, 2006). Thus the main value measures for projects, as displayed in literature are:

1. Cost of the project
2. Timescale
3. Scope
4. Quality
5. Clients + Stakeholder Satisfaction

Table 16: Value measurement criteria projects

These five criteria will be used to measure value of projects in the case studies to be followed in a later stage of the research. However, in order to know how these criteria can be measured several tools will be provided in the next section.

2.7.3 Tools for Quantifying the Measurements of Projects

As the criteria for projects will need to be measured, tools shall be illustrated that allow this. The interview protocol shall also include these methods and tools in order to collect the final list of tools applicable not just in literature but also in practice.

Criteria	Methods	Tools
Cost [1, 5]	Forecasting	Earned Value Management
	Performance Reviews	To-Complete Performance Index (TCPI)
		Reserve Analysis
		Cost Management Plan
		Budget Consumption Chart

Timescale [4]	Project duration review	Schedule Performance Index
Scope [5]	Functionality delivered as agreed upon?	Evaluations
Quality [1,2]	Effectiveness (team members, product owner, team leader)	Quality Assurance
	Efficiency (team members, product owner, team leader)	Conflict Management
	Plan & Define requirements achieved	
Clients + Stakeholder Satisfaction [3]	Emotional response to outcome of process	
	Ratio results of project compared to expected	
	Degree of focus on customer issues	
	Involvement throughout the process	

1. (Newton, 2015) 2. (Lindsjorn et al., 2016) 3. (Buresh, 2008) 4 (McArthur et al., 2017) 5 (Martinelli & Milosevic, 2016)

Table 17: Value measurement criteria for projects

The tools that are displayed in the table are a mixture of traditional and agile methods. Once these tools have been categorized into conventional methods that characterize infrastructure projects and agile methods, during the case studies it will then become clear how people value their projects.

Answering sub-question 2
In order to be able to measure value of projects, firstly a definition of value of projects was researched upon. Once the definition was clear, ways of measuring the value were researched.

The measurements for value of projects found in literature relate to the final product delivered to the client(s). Several measures have been found, but through cross-referencing the most reoccurring measures have been selected in order to demonstrate in later sections of the research what the value of current practice is. The measures are strongly related to the iron triangle adapted in conventional project management (scope, cost, time, quality). Besides the iron triangle, clients and stakeholder satisfaction will be measured. Moreover literature has provided this research with several methods and tools, which will be examined in the surveys and case studies. Additionally in the research the survey results will show how the projects are valued, as respondents will need to evaluate the performance of each criteria in a specific project.

2.7.4 Defining Value Management for Project Processes

Now that the definition of value management of a project has been established, the following four definitions shall explain how the process of value management can be defined, as the research thesis shall also elaborate on value management in the process of project.

"Value Management is a style of management; particularly dedicated to motivate people, develop skills and promote synergies and innovation, with the overall aim of maximizing the performance of an organization. At the operational level (project oriented activities), it implies in addition the use of appropriate methods and tools."
(DACE, 2017)

"Value Management integrates the operational managers' efforts with those of higher management by concentrating objectively on outcomes, which are in line with overall corporate objectives, in preference to local or short-term priorities."
(Kelly & Male, 2005)

"A service which maximizes the functional value of a project by managing its development from concept to completion and commissioning through the audit (examination) of all decisions against a value system determined by the client."
(Thiry, 2002)

"Value Management is a planned, multidisciplinary group decision-making process that supports the improvement of the value of a project, process, or product in a manner consistent with the business goals of the stakeholders and customers."
(Stenlund, 2010)

The important key terms have been underlined in the definitions above. From these definitions the terms that are considered are: tools, managing, integration, concept to completion, project-oriented activities. Thus using these key terms, the following definition can be formulated:

*"Value Management in terms of a **process** is the integration and satisfaction of the completion of activities from the concept to completion of a project using the appropriate tools that meet the client's needs."*

2.7.5 Measuring Value of Project Processes

Value management in construction is increasingly being seen as the term that describes the complete process of enhancing value of a project. Still even though value management has existed for quite some years, this method is rarely used in the development process of construction projects, instead it is mostly used for defining value for projects (Lui et al., 2006).

(Ebbessen & Hope, 2013)	**(Chase, 2001)**	**(Kerzner & Saladis, 2009)**	**(Siles, 2010)**	**(Fleming & Koppelman, 2016)**
Schedule	Schedule	Activities (planning)	Schedule	Schedule
-	Stakeholder satisfaction	Stakeholder engagement	Stakeholders	-
-	Team organization	Teamwork	Team	Team
Budget	Desired budget	-	Budget	Budget
Resources	Tools	-	Information	
Scope	-	Progress	Scope	Scope
-	Effective communication	Communication	-	-
Risk	-	-	Risk	-
Quality	-	-	Quality	-
-	People	Trust	-	-
-	-	Cooperation	-	-
-	Time allocation	-	-	-
-	Coordination	-	-	-
-	-	Contract	-	-
-	Performance	-	-	Performance

Table 18: Overview value measurements for project processes

As the list is more varied, and some of the criteria seem still seem to be considerably important have only been mentioned twice, all criteria that have been mentioned 2-4 times shall be considered. This provides a final list, for traditional project management, of 11 elements criteria:

1. Scheduling
2. Clients + Stakeholder satisfaction
3. Project teams
4. Budgeting
5. Performance information
6. Resources
7. Scope
8. Communication
9. Risk
10. Quality
11. Individual attitudes
12. Managing changes

Table 19: Value measurement criteria project processes

However, referring back to the values stated for agile project management, flexibility is a very important aspect that allows value generation faster and continuously. Therefore, a 12th criterion has been added to the list.

2.7.6 Tools for Quantifying the Measurements of Project Processes

As the criteria for project processes will need to be measured, tools shall be illustrated that allow this. The interview protocol shall also include these methods and tools in order to collect the final list of tools applicable not just in literature but also in practice.

Criteria	**Methods**	**Tools**
Scheduling [1, 2, 6, 7, 8]	Documentation	Activity Network diagrams
	Time buffers	Gantt chart
	Scenario planning	Timeboxing
		Critical Path Method
		Burn down chart
		Buffer chart
		Milestone prediction chart
		B-C-F Analysis
Clients + Stakeholder satisfaction [1, 6, 8, 12]	Engagement	Balanced scorecard
		Clients' valued prioritization
		Prioritization ranking
		Stakeholder mapping
Project Teams [3, 4]	Coordination	Trainings
	Mutual Trust	
	Balance of team member contribution	
Budgeting [1, 2]	Cost forecasting	Activity based costing
		Earned Value Management Analysis
		Planned / Actual costs Excel
Performance information [1, 2, 5]	Openness to stakeholders and clients about progress	Completeness of requirements
		Cost performance index
Resources [2]		Facilities
		Trainings
Scope [2, 9]	Scope Statement	SWOT Analysis
		Product Breakdown Structure
		Work Breakdown System
Communication [1, 6]	Formal reports	Design structure matrix
	Action plan	Peer Reviews
	Project Management Plan	Stand-up meetings
Risk [8, 9, 10, 12]	Risk identification	Risk Management Plan
		Risk Assess Matrix
		Decision Tree

		Risk adjusted backlog
		Risk Impact Assessment
		Risk Prioritization Analysis
Quality [1, 2, 6, 11]	ISO 9001 Quality Management	Value stream mapping
		Value driven Cost-Benefit analysis
		Pareto diagram
		Quality Assurance
		Value-driven KPI's
		Best Value Approach
Individual attitudes [2, 5]	Innovation and learning	Thermometer approach
	Motivation	
	Participation	
Managing changes [2, 9]	Flexibility	
	Number of interrelations	Retrospectives

1. (Chase, 2001) 2. (Newton, 2015) 3.(Lindsjorn et al., 2016) 4.(Moe et al., 2010) 5.(Pennypacker, 2005) 6.(Nicholas & Steyn, 2012) 7.(Parente, 2015) 8.(Griffiths, 2012) 9.(Bosch-Rekveldt et al., 2011) 10.(MITRE, 2017) 11.(Scott & Program, 2006) 12 (Martinelli & Milosevic, 2016)

Table 20: Value measurement criteria for project processes

Answering sub-question 3

The measurement of project processes is often completed implicitly. Thereby making it difficult to measure. Increasingly, literature has recognized the importance of process measurements in terms of performance measurements in order to generate value both for the process experienced as well as the project. Measurements in project value have been completed for many years, and process measures are increasingly starting to be implemented. This can also be related to agile project management influences, where regular evaluations throughout the process are recognized to be an important aspect of the project process.

Likewise a cross-referencing literature study was completed in order to identify the most frequently recognized project process measures. For this research process value will be measured through twelve different criteria: scheduling, clients + stakeholder satisfaction, project teams, budgeting, performance information, resources, scope, communication, risk, quality, individual attitudes, managing changes. Additionally, literature research was dedicated to different methods and tools used to measure the different criteria. Through survey and case study research these measures and criteria will be analyzed. Moreover the current value of project processes will be analyzed in order to discover way of improving the current value of project processes when using agile project management.

Conclusion

The literary subjects researched upon originated from the project scope, namely: early project phases, construction industry, agile project management, and value management. As discussed, if value is not correctly identified in early project phases this will have a consequence in later project phases. During the early project phase very little is known about the project activities and execution, establishing considerable uncertainty. As current project management is experiencing issues with coping with the complexity and demand for changes, the agile project management can possibly add value to aspects of conventional project management. Typical infrastructure project characteristics were analyzed (i.e. well-defined scopes, resistant to change) as well as the problems in current project management (i.e. complex interfaces, scope changes over time) in order to establish how agile project management can respond to these demands. Agile project management was defined in the literature review as an iterative process that is able to continuously improve deliverables through increased collaboration and flexibility ensuing increased customer value in projects. Value generation is a major focus of the agile project management methodology, thereby responding to the demands in current practices.

The difference between the two project management methodologies was explained in section 2.4. For example, a difference that can be established is that the conventional approach attempts to minimize change whilst agile project management incorporates changes. Moreover, as some

typical construction characteristics might not be able to change, a hybrid form of project management was also introduced.

Altogether the literature review analyzed which elements of agile from the ICT might also be applicable to the construction industry. To summarize the results, a list of elements was provided in section 2.6. This list of elements will be applied in the research in order to reveal the added value of agile project management in the construction industry during early project phases.

Moreover in order to establish added value, value management was analyzed in terms of projects and project processes. As the literature review states value for project is defined as: directed towards the delivery of a product or a service to clients and stakeholders at an optimum quality and performance as well as at an acceptable cost and schedule. The definition provided for the value of project processes states: value management in terms of a process is the integration and satisfaction of the completion of activities from the concept to completion of a project using the appropriate tools that meet the client's needs. For each of the value management elements, measurement criteria were established that provide this research with an insight on how the criteria performed in projects and processes during the survey and case study research.

CHAPTER 3
Exploratory Interviews

3. Exploratory Interviews

In order to establish the role of W+B in early project phases, understand their perspective on value management in projects and processes, their familiarity with agile project management, as well as the main project management problems they are experiencing – exploratory interviews have been completed. First some general information about the respondents will be given, followed by the interview outcomes on the definition of early project phases, value- and agile management.

3.1 Respondent Characteristics

The respondents were found through the company's internal database. In this database the researcher was able to search for certain capabilities such as certifications, projects, and departments. For the interview a protocol was written (Appendix B1). The section below will summarize some general information collected about the following six interviewees.

Respondent	Working experience	Educational Background	Function W+B projects
1	8 years	MSc. Business Development	Project Leader for masterplans
2	35 years	MSc. Civil Engineering	Specialist Systems Engineering
3	27 years	MSc. Water Management	Project Leader ecology projects
4	26 years	MSc. Offshore	Project Manager or Technical Manager
5	10 years	MSc. Construction Management & Engineering	Sub-Project Leader: Sustainability Advisor
6	15 years	HBO Civil Engineering	Project Leader

Table 21: Respondent characteristics exploratory interviews

A similarity that all of the interviewees have in common is that they are all involved in project leadership and have a diverse background. Correspondingly the interviewees are all working at different divisions within W+B. This allows for a broad representation of the general vision on early project phases, value management, and the implementation of agile project management at the company. The sections below shall summarize the findings from the interviews. In case a quote is literally taken from an interviewee, the respondent number will be provided as a superscript.

3.2 Defining Early Project Phases

Overall, the early project phase is the preparation phase, where the project aim is established, and when aspects are taken into account for the project scope [5]. In order to define the early project phase involvement for W+B, the MIRT (meerjarenprogramma infrastructuur, ruimte en transport) manual is used as guidance that can be applied to identify phases in projects. Rijkswaterstaat established the manual, but as many of the projects completed by W+B are for RWS, this manual often applies. The manual describes four main steps to be undertaken in early project phases, namely: the start-up of a project where the problem is analyzed; the analytical phase where different solutions are generated; the assessment phase where the different alternatives are evaluated; and the decision-making phase where preference solution is selected. W+B participates in early project phases in all activities before an actual solution study is performed before a choice is made whereby a budget and solution has been assigned [1]. Nonetheless the phases as described by the MIRT in practice are not applied as strictly. Therefore it will be better to focus on the activities endured in the early project phases in order to establish a proper overview of the early project phase.

Aforementioned, during the early project phase the project problem will be determined as well as who is involved and what possible solutions there are. Activities in the MIRT guide include a start document, several promising solutions, cost-benefit analysis, and an environmental impact report [1]. In addition to these activities when not only taking MIRT projects into account, other activities are also included in the early project phase such as the contract form, sustainability of the project, which permits apply and the process of the permits [5].

When involved in the second stage of the early project phase, where different solutions are considered there are two main methods to be completed in the stage. This can be done either by involving the client and specifically asking them what they would like the result to be or by

asking the client when they would consider the project to be successful. Often, in the case of a project for the municipality the request will be if the local residents are not complaining and the project runs smoothly as well as if the project will be finished on time. Additionally, if the request of the client is clear, then the client can expect a proper answer. Thus this is essential to keep in mind during the early project phase [6].
Another method that can be applied in early project phases is best value procurement or often referred to as best value approach. The early project phase is where the perspective of a project manager and the role of W+B in the project are determined. The moment W+B is selected but there is not yet a contract is the earliest phase where W+B is involved [2].

For the amount of time projects usually take in the early project phase, all of the interviewees answered consequently. Their response was that it is difficult to quantify as all projects are different and overall there is never enough time [2]. Nonetheless all respondents recognized the difference between small and larger projects. A small project will usually be completed by just one employee and often requires a quick scan. This normally doesn't take longer than a few months (up to six months) [1][5]. For a larger project, this normally takes longer – mostly around a year [4]. The time per role within a project also differs quite a lot. For example a project leader writes the project management plan and is involved greatly during the start-up of the project as well as at the end of the early project phase. The project employees complete the activities in-between the start-up and end. The time will depend on the amount of products to be delivered within the early project [3].

The amount of parties and employees involved in projects fluctuates strongly as this depends on the size of the project [2]. Approximately when the project is under 100,000 euros it may happen that there are no subcontractors involved. Even without a subcontractor, still many other stakeholders can be involved. The amount of different stakeholder parties does not necessarily change whether you are in the earliest phase of a project or in a later phase. Generally speaking, dozens of stakeholders are involved [3].
For large projects up to 20,000 stakeholders have been measured (this includes the local residents) [4]. Taking a large plan study project into consideration, example of stakeholders can be the province, owners of preserved nature areas, surrounding municipalities, recreational associations, and fisheries. One of the respondents who had a particular project in mind stated that it was also possible to include subcontractors and a research institute for a single detached assignment from the authorities. The information they provided in that particular project was also used in the development of solutions in the early project phase. Conclusively, the stakeholders are different for each type of project and location [1].

Likewise, the amount of employees also differs per project. Commonly this can be between one to thirty employees [1]. Generally approximately ten employees are involved for a project of a few hundred thousand euros. Nonetheless these employees are rarely involved on a fulltime basis. Normally they work two to three days a week on a project [3]. Also additional employees may be asked for their expertise for a very short period of time. This will mean more employees are involved but less intense in comparison to the people working on the project over a long period [4].

Regarding project management in early project phases, W+B provides much flexibility for employees [5]. As a starting project manager, a three-day course is compulsory. Again a different three-day compulsory course is also provided for employees starting a new function as project leader. The different project management methods, which are also taught during these courses, are combined in a project management manual. However, there is no best practice method, every employee is allowed to cherry-pick as they wish [2][1].

Hence, the external parties, employees, time and activities of projects in early project phases depend on the size of the project. Generally W+B is not involved in very beginning of the early project phases, established as a 'verkenning' in the MIRT manual. The company is more involved in later phases of the early project phase, such as plan studies. For all the large and complex projects, most of the time a core team is established with several project leaders that are each responsible for a design cluster – thereby still maintaining a (minimal) hierarchal approach to project involvement. As there is no main compulsory project management method, employees are flexible to try out and apply techniques they believe in or consider to be of potential benefit

to that project. Thereby the most used technique is to consider what the client is expected and would like to see and respond to these requirements accordingly.

3.3 Defining Value

Most of the respondents interpreted value as the value for the client but also identified value in relation to W+B. One of the respondents mentioned that value for the client can't be achieved in case W+B will lose sight of their own values [1]. If the employee isn't motivated and/or satisfied with the project this can often also have an influence on the value delivered to the client [2][6]. A way to question whether value is delivered to the client is to ask is if the product is also what was expected [4]. Value can be defined as that what is considered to be important. Therefore when you consider why you are doing something and you continue to ask why – at a certain point you will not be able to ask the same question anymore. At this point you will have achieved value [3].

W+B is known for valuing quality highly. However, W+B and the client may interpret quality differently. An expert may be interested in a detailed report of the solution or calculation whilst the client is often simply interested in a presentation of the solution instead of a detailed report [1]. A way to quantify quality is through the Best Value Procurement which forces you to critically describe what W+B will achieve in the project in no more than two A4 sheets [2]. Using key performance indicators W+B describes the deliverables in the project as well as how. Additionally the potentials identified by W+B and the added value that will be delivered when choosing W+B is described [1].

Value management

When the interviewees were asked if they use tools for value management in their projects or processes, generally no clear answer was provided. The researcher was able to explain certain tools and methods researched upon, which is how the respondents concluded their answers. Thus the exploratory interviews have taught the researcher that during the actual case study interviews this approach will need to be altered and guided accordingly. A list of tools and methods found in literature will need to be provided to all of the interviewees.

Nonetheless, some tools were discussed during the exploratory interviews. A cost-benefit analysis was considered a value tool for money and interface management as a value tool to measure the process. Interface management is measured through surveys regarding transparency, communication, planning, budget, cooperation and involvement [1][3]. Another tool for value that can be considered is best value procurement (Appendix A4 for more information). Also key performance indicator (KPI's) is a tool that measures the value of quality through measuring the product specifications, and client requirements [1]. An additional tool considered for information is the P-schijf, which is where all the project information must be placed [3]. Furthermore sustainability can be used as a value tool. It should be taken into account in a project as this allows for solutions that consider additional value also for the environment – defined as social return [5].

All respondents considered there to be a difference between value in projects and project processes. However when defining the concrete difference between the two, especially in relation to measure the different types of value – difficulty was experienced. In the discussions with the respondents they mentioned that a project could be measured through the different phases necessary in order to complete the project as well as if the aim is achieved [1] [5]. The final product will be the value [3]. In a process often in the first phase it is unclear where the process will lead [1]. A process is the means of achieving the higher goal, being the project [5]. The importance of a process is found in the cooperation with the client, if this goes well it could lead to future projects. Some employees at W+B are seeing the need of measuring client and stakeholder satisfaction not only at the start and end of a project but also during the process. However, as there is no standard method on when to measure this and also due to time constraints, this is often neglected [3]. Hence the difference in definition for value of projects and processes is only clear to a minimal extent. Especially the way to measure the value of the two is lacking.

Regarding measuring the value of projects most of the respondents considered GOTIK (translated to money, organization, time, information, and quality) as a way of measuring value. However these project values are only described in a progress report [1][3]. One of the

respondents emphasized the subjective character of project value measures [2]. W+B often sends satisfaction statements at the end of projects, however the question arises whether this is beneficial. A main way of measuring a project value is completed through KPI's, however there is insufficient experience in measuring this project value [2].

Process value is not able to directly translate back into money, making it more difficult to measure [6]. Using the same GOTIK criteria the process can be guided. In addition to these criteria client and stakeholder satisfaction should be measured [1]. A way to measure overall project satisfaction is through the thermometer approach. However this is rarely actually completed. One of the respondents mentioned to have attempted this approach but only for one session in a past project. Before the project meeting, every stakeholder was assigned a magnet and was requested to place it somewhere on the thermometer (ranging from 0 to 10) to visualize their level of satisfaction. When stakeholders were in the danger zones, this was then discussed during the meeting [6].

Thus overall in current practices W+B often measures value implicitly. Measures of project and process are taken into consideration in the progress reports [1]. Furthermore an explicit understanding of the difference in project and process management is missing for most employees, as mentioned by the respondents [1]. Additionally measuring is often considered as something that is done intuitively as there is no standard way of doing so at W+B. However, as the client tends to prefer an explicit approach to value measurements it would definitely be something to look into once a standard method has been developed at W+B [4][6].

Next the respondents were asked whether they regarded value for W+B and the client to be different or the same. The respondents agreed that value for the client and for W+B is different. Value for the client can be achieved at the end project, when expectations are satisfied [1]. Value for W+B is found in the 'duurzame ontwerpprincipes' as well as the experience in projects [1]. This allows W+B to deliver value in projects and potentially stand out in comparison to other companies [5]. Even though a difference can be found, a balance between the values for both should be found [2]. Value should be divided evenly in a project [3]. However, if a choice had to be made, value for the client will be more important according to some of the respondents as this is how money is earned [1]. According to another respondent, it depends on which employee will answer as the respondent mentioned that a senior partner would choose W+B above the client [5]. Reasoning for choosing W+B could be that focus on continuously improving internal processes is also of added value for the client [6].

The respondents recognized that reports often state that the expected value is not delivered optimally. However this is mostly discovered at the end of a project when the value at least of the process can no longer be altered. Also recognized is that currently people are not aware enough of the value that must be delivered. This could be a reason why value is currently not optimally delivered [1]. Project leaders are aware of the value expected by the client but often the rest of the employees are not, as their position in the organogram is too far away from the client [6]. As they are not in contact with the client enough, they will not feel the same responsibility as the project leader and are less aware of the value the client needs and is expecting. This distance is often chosen in projects, as specialists should be given the opportunity to focus on their own work. By involving specialists too much with the client they might overwhelm the client with additional expert information that is considered less important for the final solution presented to the client [6]. A way to deliver more value is found in the potentials of integral design, which is slowly being introduced at W+B [5]. Again as aforementioned, added value is delivered through aspects of projects delivered above what is expected by the client. Moreover through interface management, miscommunications can potentially be eliminated and add value in the deliverables [5].

Conclusively, for the company quality seems to be the most important measure that sets W+B apart from competing companies. The main tools used to analyze value are KPI's, cost-benefit analysis and interface management. Furthermore all respondents, however not clearly explained, recognized a difference between value in projects and processes. For both measures the GOTIK criteria was considered to be appropriate. Moreover, client satisfaction in project processes should be measured or reported at the beginning and end of the project, and possibly during the process. Additionally, a difference between value for W+B and clients can be found but a clear

balance should be attained. Lastly the main losses in current value delivery can be found in client value awareness and communication.

3.4 Implementation of Agile Project Management

Half of the interviewees were not aware and had never heard of agile project management [3][4][5], one interviewee considered scrum to be a tool used for lean [6], another partially used scrum elements in a project [1], and another interviewee was aware of the scrum methodology but has not used it in projects [2].

A reason for not having applied agile project management is that the respondents considered believing in the methodology but found the mentality behind the methodology very difficult to implement. W+B is currently still very hooked on the waterfall methodology [2]. Employees are used to receive assignments and acquire the time to develop them and return after a few weeks with the result.
Another interviewee mentioned to have completed an Arpa course for scrum and partially implemented elements of agile. Difficulties were found in the size of the team, as the project teams are often large making it difficult to organize daily stands. Thus in the respondents experience the project core teams only got together. Sometimes a particular expertise was also asked to join the stand-up session simply once. Additionally experience with scrum was that it was very expensive to train employees and organize sessions where everyone could attend [1].

As most employees are not aware of the agile project management methodology, they were asked to state the main problems experienced in current project management practices. Information flow is considered to be a major problem. As people work at their own locations many emails are sent including many people in the carbon copy, making mailboxes overflow and chaotic. Also in case something alters in a report, it is often a problem to also alter this is all of the other versions of the reports used by different disciplines [1]. Another respondent mentioned project descriptions and controls. From experience the respondent mentioned that project leaders are often doing many tasks in a project instead of navigating the team [2]. This can lead to bad communication or lack of communication that can result in misunderstandings [3]. Another problem experienced is structure in the flexibility of allowing changes in the planning and documentation. Informing the team and keeping employees motivated is a very important aspect [4]. Lastly, there are many employees at W+B with many years of experience which is not shared enough to project managers that are less experienced. More can be achieved in the learning process internally [5].

Solutions for the problems mentioned above were generally not provided, as the interviewees stated that if the solution would be there – W+B would use it. An idea to spread information would be through an innovation platform [1] and monthly meetings with project leaders with different amount of years of experience to share their ideas and practices [5]. For communication, a way to avoid miscommunications will be to physically be at the same place more often, as long as people still have the time to focus on their own work [3][6]. Additionally a lot of changes are retained due to a change in mentality. A way to change this is to give people a voice and let them express their opinion. Lastly the whole team should also be aware of the appointments and expectations of the client in order to feel responsible for their work and deliver on time [6].

Conclusively, most of the interviewees were unaware of the agile methodology and the employees that were involved with lean seemed to consider the daily-stand ups and scrum sessions as part of lean instead of agile. Hence it might be interesting to interview the training company to see how the employees were trained. Furthermore the current problems in project management seem to all be applicable to the agile project methodology. For example the amount of emails sent to each other can be reduced when more short efficient project meetings are held and people work at the same location more often. Thereby alterations in reports are also completed more quickly and everyone is aware of the project process. Through self-management of teams and including the client(s) in the entire process, all employees will feel more responsible of their work and will be aware of the expected deliverables. Important values for the client can also be communicated better by discussing progress in shorter phases.

3.5 Comparing Literature and Exploratory Interview Results

In order to develop this research and have a proper understanding of the current practice of the early project phase, the use of value management and to what extent agile project management is already implemented, the results will be compared to the literature review from the previous chapter.

As the table for early project phases (table 22) indicates, most of the outcomes of the exploratory interviews overlap with the results from the literature review. The definitions of the early project phase both state the need to identify the aim of the project. For the activities engaged in during the early project phase, some differences were established. These differences were mainly due to the level of detail for the project. In the literature review, the literature stated general activities such as a kick-off meeting and client requirements whilst the exploratory interviews also established more detailed activities such as an environmental impact report and permit process. Furthermore, the duration of the early project phase was both identified to be up to a year. The amount of parties involved remained rather general in both research methods, as both literature and the exploratory interviews acknowledged that this was very project specific and often greatly varies. In general the type of parties are mentioned instead of the exact number as sometimes a party can also only be involved for one small part of a product. Lastly, the same reasoning about project types was provided for the size of the project team. The respondents mentioned that employees don't work on projects daily, instead two to three times a week. Moreover, the respondents stated a general average of approximately ten employees whilst literature stated an average of a total of thirty-four team members throughout the early project phase. The difference in reasoning between current practice and literature is that the respondents mentioned the average amount that is always busy with the project, whilst literature mentioned the total general amount during the entire project.

Early Project Phase		
	Exploratory Interviews	**Literature Review**
Definition	Preparations phase in which the aim of the project is established.	Phase where the project aim is established and in high uncertainty, but also most important for innovative activities and the planning of the project execution as well as value identification.
Activities	Compose start document, Assemble project organization, Cost-benefit analysis, Scenario analysis, Environmental impact report, Problem analysis, Assessment phase, Decision-making phase, Form of contract, Permit process	Project objective definition, Client requirements, Kick-off meeting, Identifying project team, Planning, Set of alternatives, Preferred decision
Duration	On average mostly 12 months	Average duration of 12 months
Amount of parties involved	Up to 20,000 stakeholders for complex projects	Multiple stakeholders for example the client, project manager, surrounding residents, owners, public bodies
Size of the project team	Approximately 10 employees that work 2-3 days a week on the project.	On average 34 team members

Table 22: Comparing exploratory interview with literature on early project phases

As most of the respondents were not aware of agile project management, it was difficult for the respondents to identify to what extent agile project management was already being implemented. Table 23 identifies the activities identified in the interviews and in literature.

Altogether the respondents mentioned to currently implement stand-up sessions and lean planning, as elements part of agile project management as that is what they were taught during their project management course. However, lean planning was not considered as one of the

activities for agile project management in literature. If the activity of lean planning were related to literature it would mostly fit to re-prioritizing requirements and activities.

Implementing agile project management		
	Exploratory Interviews	**Literature Review**
Activities/ characteristics of agile in projects	Stand-up sessions Lean planning	Feedback sessions Retrospectives Iterations Frequent face-to-face communication Sprint planning (small releases) High customer involvement on-site Adaptable projects People oriented Collaborative development Cross-functional teams Simplicity in designs Self-management of teams (small teams) Re-prioritizing requirements and activities Frequent deliveries in short iterations Evolutionary development Minimizing documentation Incremental approach

Table 23: Comparing exploratory interviews with literature on implementation of agile

Regarding the definition of value, the respondents mentioned that value could be defined in two ways, namely: in the value for the client and the value for the company. Contrary, literature defined value in terms of project and project processes. In addition to the difference in value definition, the interview results showed that the respondents were not very aware of the differences for measurement criteria for projects and processes. Although the respondents mentioned to see a difference between project and process value, all of the respondents mentioned to generally measure value implicitly and also in the same way. Regarding project measures, literature additionally stated client and stakeholder satisfaction and the exploratory interviews stated to also measure information and organization next to costs, time and quality. For processes, literature stated to also measure the interim clients and stakeholder satisfaction, resources, scope, communication, risks, individual attitudes and change management whilst the respondents did not mention any extra criteria next to the same as for projects, namely: costs, organization, time, information and quality. Therefore as the respondents were not very familiar with the measures of value management, their main outcomes on tools for value management remained rather limited (cost-benefit analysis, interface management, key performance indicators), whilst in the literature review a very extensive list of tools was gathered.

Value Management		
	Exploratory Interviews	**Literature Review**
Defining value	1. Value for the client 2. Value for the company	1. Project: Value Management in terms of a project is directed towards the delivery of a product or a service to clients and stakeholders at an optimum quality and performance as well at an acceptable cost and schedule. 2.Process: Value Management in terms of a process is the integration and satisfaction of the completion of activities from the concept to completion of a project using the appropriate tools that meets the client's needs.
Tools for VM	Cost-Benefit Analysis, Interface Management, Key Performance Indicators	Different tools for projects and processes. Extensive list in table 17 and 20

Measurement Criteria Projects	Costs, Organization, Time, Information, Quality	Cost of the project Timescale Scope Quality Clients + Stakeholder Satisfaction
Measurement Criteria Processes	Costs, Organization, Time, Information, Quality	Scheduling Interim Clients + Stakeholder Satisfaction Project Teams Budgeting Performance Information Resources Scope Communication Risks Quality Individual attitudes Change Management

Table 24: Comparing exploratory interviews with literature on value management

Conclusively, as the comparisons show generally a lot of similarities were established in the definition of the early project phase. However the interpretation and use of value management as well as agile project management was rather limited in practice, compared to the results established from the literature review.

Conclusion

Overall, the exploratory interviews have provided a proper insight into current positioning of W+B in early project phases, the type of project organizations engaged in, the incorporation of value management in their current practices as well as their vision on the implementation of agile project management.

The respondents defined the early project phase according to activities, as there is no strict definition for the different project phases. As a lot of the projects are performed for RWS, the MIRT guide can be an option. Nonetheless other projects outside of the MIRT scope also engage in additional activities. When referring to the MIRT guide, generally, W+B mostly completed plan study projects in the early project phases. According to the respondents, no particular project management methodology is applied in projects. Instead a mix of different approaches is applied in order to satisfy the client's needs.
Moreover the project organization of teams mostly exists of a core team. Within the core team employees will each have a cluster group they will be responsible for.
When the respondents were asked how they would define value as well as deliver and control it in their processes and projects a silence was noticeable in all interviews. Evident was that all respondents considered value in projects to be very important, however none of the respondents had a clear vision as to how this could be measured. Each had some ideas, but none were consequently already being implemented in current practice. Generally progress reports only briefly describe the value of the process and project, leaving the measurement of value implicit.

The last aspect of the interviews discussed the respondent's awareness of agile project management and the problems encountered in current project management. As mentioned, half of the respondents had never heard of agile and the other half who had heard of it recognized it as a tool for lean or had not used it.
The problems experienced in current practices are mostly related to communication and motivating teams, and information flows. Regarding agile project management, these problems could possibly be tackled. An example would be to reduce the amount of emails sent out and hold more short efficient on-site meetings on a regular basis. Additionally by planning review sessions, employees will also be able to express their opinion and feel more involved in the project. Communication in relation to the client could be resolved by breaking projects up into smaller projects and delivering more frequently. By doing so, regular feedback from the client will be received and adjustments can be made within the regular project time, thereby possibly minimizing overruns.

CHAPTER 4
Research Methodology

4. Research Methodology

The literature review has identified possibilities for the implementation of agile project management in the construction industry. Additionally, how value can be measured in projects and project processes was researched upon in order to be able to conclude how the agile project management methodology can add value. In this section, the research methodology will be explained. The research can be divided into three main steps. Firstly in-depth case study analysis will be performed that will allow the researcher to establish value management in current practices as well as problems and opportunities in project management. The second step will completed through data gathering from the surveys. The surveys will allow the researcher to distinguish the value of project and project processes of agile project management elements. These two steps will be compared to each other in order to establish a conceptual model for the added value of agile project management in early project phases of infrastructure projects. The third step in the research will then be completed, which will be expert validation. An expert panel will be established to validate the conceptual model. The steps as mentioned will be described in-depth in the following section.

4.1 Case Study Set Up

For the exploratory interviews, a protocol was made (see Appendix B1), which during the interviews showed to have positive sides and weaknesses. The remarks of the questionnaire have been taken into consideration for the completion of the case study protocol. The definite protocol for the case studies can be found in Appendix B2.

4.1.1 Selecting Case Studies

The case studies were chosen after having completed the exploratory interviews and having attended the DACE special interest group meeting. As agile is particularly unknown at Witteveen+Bos, it took quite an effort to find appropriate case studies. The selection was based on activities, department (only infrastructure), and availability. The following paragraphs will elaborate on the selection procedure.

Project activities

After the exploratory interviews the choice was made to develop a list of activities that were considered to be part of the early project phase by the six respondents. These activities were then ordered and used to find appropriate case studies. The phase names provided by Witteveen+Bos that are included in these projects as early project phases are: initiative, exploratory and plan studies.

Selecting case studies

A total of five different case studies will be studied. As the cases were all selected upon agile element characteristics, the amount of choice for case studies was limited. A total of two cases were suitable for the research and have been recently completed. The other projects that were eligible for this research were either stopped half way or not yet completed. Thus, the researcher chose to also include partially completed or running cases in order to increase possibility of the case study analysis. The partially completed project has already completed a phase in the early project phase and will complete the entire early project phase in October 2017.

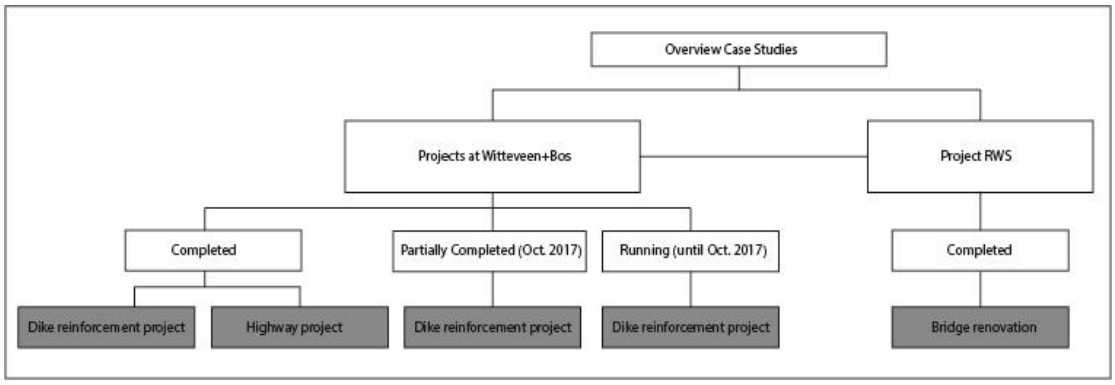


Figure 12: Case study set-up

The running project (until October 2017) was chosen as this allowed the researcher to also attend the planning sessions and project meetings and next to the in-depth interviews see which elements are actually being applied in current practice. As the completed projects are able to definitely state the entire process and project outcome, it will be important to mostly focus on completing the interviews with respondents engaged in completed projects first. As the company had a limited amount of infrastructure case studies available for use in the early project phase with acknowledgement of agile elements, the researcher searched for a project outside of the graduation company after attending the DACE meeting. This resulted in a case study at RWS.

4.1.2 Choosing interviewees

After having selected the case studies, the interviewees were to be selected. For all case studies first contact was made with either the project director or the project leader/manager. They were asked if they were interested in an interview and helping the research. Additionally, once they showed interest they were asked for advise on whom else to interview regarding this topic. As they were informed that the researcher aimed to interview four to five employees per case study, they generally advised around five to six people in case not every employee was available. This allowed the researcher to still be able to interview the required amount of employees per case study even if some of the employees rejected the request. Especially due to summer holidays, some of the employees responded that they were too busy. However, generally most people were open to an interview. The first interviews were conducted before the summer and the last was conducted at the end of September. A total of 22 employees were interviewed from four different companies. Their functions will be enlightened in the case study data analysis section.

4.1.3 Interview Set up

The exploratory interview protocol was very useful as this showed where the drawbacks were for the research set-up. As value measurement criteria were experienced as difficult for all of the respondents, for the case studies the approach was chosen to provide interviewees with examples taken from literature. Moreover every interview took around one hour to 1,5 hours and was conducted face-to-face. The interviews were conducted in Dutch and recorded. The recordings allowed the researcher to transcript the interview and translate the interview to English. Once the interview was transformed to a transcript it was sent to the interviewee to check, correct where necessary, and provide permission to be used for this research. The transcript was sent to the interviewees at latest a week after the interview, to ensure that the interviewee was also still concisely aware of the discussions during the interview.

Interview Protocol

As stated by Yin a case study protocol is required to ensure reliable data (Yin, 2003). Thus a protocol was also set up for the cases studies. Moreover the same protocol was applied for every interview, thereby minimizing bias in the outcomes. The protocol can be found in Appendix B2.

The protocol began with some general information about the interviewer and interviewee. However this was rather concise as the researcher had met most of the interviewees before the interview and already explained the research. Additionally, most of the interviewees had also filled in the survey, which also asked for personal information.

The next phase in the interview questioned the interviewees about the early project phase. Questions regarded activities, durations, team size, team organization, parties involved, project management method, and the project management plan. These questions provided the interviewee with an insight into how large the project was and also how traditional the practices were.

Following were questions regarding value management. The interviewees were asked how they would define value for the case study and how they made sure that value was also delivered and controlled in a certain way. They were also asked if defining and controlling value was something they (and the company they worked at) considered to be important. Next they were asked if they considered value for a project to be different from value for a process. Accordingly they were they asked which value criteria they measured and how each criterion performed within the project and process. Following they were asked how they measured the criteria they had stated to measure. Lastly questions were asked about the current drawbacks in value delivery and on their opinion on what should change in order to deliver value (and possibly optimal value).

Lastly, the protocol consisted of a project management section of questions. Firstly the interviewees were asked if they had experience with agile and if so how and what their opinion was on agile. Furthermore they were asked about the problems in current project management and what their opinion was on how this could be improved. Finally, they were asked what they would have done differently if they were to start over in the project.

As most of the interviewees also completed the survey prior to the interview, the last part of the interview consisted of questions regarding the survey. For example, why they were not experiencing certain agile elements and how they would like to experience them. Also, why they would not like to experience certain agile elements in projects. The discussions provided the researcher with an explanation of certain agile elements and develop a more in-depth understanding of the applicability of the agile elements.

4.2 Survey Set-Up

As the agile term is relatively unknown in the construction industry, the researcher has chosen to complete case study interviews as well as survey data gathering. By doing so, a broad perspective of current practice through the survey can be collected as well as in-depth questioning of drawbacks and opportunities of current practices. This will allow the researcher to develop an understanding of possible persistency's or opportunities for the implementation of agile in infrastructure projects. The choice of respondents will be explained, followed by an explanation of the development of the survey questions, an explanation of the data analysis strategy, and lastly the survey design.

4.2.1 Choosing Respondents and a Data Gathering Technique

As the proposition is that most employees will not be aware of agile, the technique for the survey was to provide employees the survey face-to-face. This allowed the researcher to be able to explain certain agile elements and properly bring across the central idea behind the survey. It also allowed for an explanation about choosing one project when filling in the survey instead of all daily practices in projects. This choice was made to be able to analyze the general project characteristics instead of the general practices in all projects.

For the case studies the researcher attended several planning meetings (in current practice referred to as lean sessions) where project employees prioritized or re-prioritized activities. This was a good opportunity to have everyone fill out a survey during those meetings, as they were then also able to ask questions.

Next to this opportunity during meetings, the researcher headed out to the main offices in The Hague, Rotterdam, Breda, Deventer, and Amsterdam. The researcher to approached employees on the work floor and explained the research and asked for cooperation. As the scope of the research encounters infrastructure projects in early project phases, only the employees from the infrastructure departments who have experience with early project phases were approached.

4.2.2 Defining Survey Questions

The survey was split up into several sections. A detailed overview of the survey design can be found in Appendix B3. The front page of the survey explained the research topic and also the goal of the research and survey. Additionally the front-page assured respondents that their answers were made anonymous in the final analysis of this research. All respondents were able to request a copy of this chapter before the research was submitted.

The survey was be set up into five main parts. The first part contained some general information about the respondent. The respondent was firstly asked to fill in their name. This seemed contradictory with what the front page stated (all information will be made anonymous). However this was simple done for an administrative manner in order to be able to contact the respondents in case the survey was not completed, or something was unclear. The rest of the general information about the respondent regarded years of experience, company, department, educational background and also if the respondent had heard of agile before. This information provided the researcher with a general background of the type of respondents who filled out the survey.

The second part of the survey asked the respondents to elaborate on the project they chose to keep in mind when filling in the survey. The respondents were asked to state the project name, their function in the project, the approximate budget of the project, and the length of the early project phase.

The third part of the survey consisted of all the agile elements possibly applicable to the construction industry. The left column of the survey was intended for the respondents to fill in how they had experienced the agile elements (arranged according to the agile themes) in their project. The right column was intended for the respondent to fill in which elements they would like to see in their projects. Reasoning for this was that respondents unaware of agile could not be using the elements in their daily practices, however maybe they would like to use these elements now that they are aware of their existence.

The next section encountered the value criteria. Firstly the fourth part requested the respondent to fill in the value of their project based on project value criteria selected from literature. Additionally this section asked the respondent is they measured this criterion. By answering if they measured the criterion this gave the researcher an idea of if the respondents measured the criterion implicitly or explicitly. The last section covered the value of the project process. Likewise, criteria were stated and the respondents were asked to provide an indication of the performance value of their process as well as if they measured this during the project process.

The researcher asked several employees at the company what their maximum amount of available time was to fill in a survey. Most employees responded to be more persistent to answer a survey that exceeded a fill-in time of fifteen minutes. Therefore the researcher chose to establish a survey that could be filled in within this time limit. This implied that closed questions should be asked rather than open questions, as open questions are often not fully completed when people run out of time.

4.2.3 Analysis Strategy

The data of the survey collected was analyzed through a correlation analysis method. The method for these two analysis methods will be explained in the following chapter regarding data analysis. For the first analysis, the entire dataset was used to analyze the relations as well as possibilities and drawbacks of agile elements in infrastructure projects. It would have also been interesting to specify the correlation per company. However, this could have only been completed if the reliability of the outcomes per company in terms of sample size were similar.

Sample Size Survey

As the amount of variables, the researched topic, the amount of options in the survey, as well as many other factors are all different for each unique survey, it is difficult to determine the minimal amount of respondents necessary for sufficient data analysis. Hence general rules of thumb were researched for the minimal amount of respondents. Many years ago Roscoe stated that for an infinite population no statistical analysis could be made with samples less than 10. Only in case of tight control, ten to twenty respondents could be satisfactory. In most cases a sample of a minimum of thirty will be satisfactory (Roscoe, 1975). Generally speaking, Hill also stated that for a correlation research a minimum of thirty respondents are required in order to be able to establish a relationship (Hill, 1998). As this survey contains many variables (38 agile, and 17 value) that could possibly form relations, it was chosen to double this amount of respondents. Therefore the minimal amount of respondents for the survey was sixty.

Variable Significance Survey Data

Whether or not variables will be significant could be assessed using standard error calculations. For this survey eighty-seven respondents were collected. The formula for standard error is (Naing, Winn, & Rusli, 2006):

$$Standard\ error\ 95\% = 1.96 * \frac{1}{\sqrt{n}} = 0.210$$
$$Standard\ error\ 99\% = 2.58 * \frac{1}{\sqrt{n}} = 0.277$$

As the formula shows, a confidence level of 95% was calculated using a Z-value of 1.96. For a 99% confidence level the standard error was calculated using a Z-value of 2.58. As the outcomes

show, for this research variables were significant at a 95% confidence level when the variable exceeded a value of 0.210. The same for a 99% confidence level whereby the variable was significant at a value higher than 0.277.

4.2.4 Survey Design

As the method of face-to-face communication was chosen for the survey, the survey was not created on an online platform. The first draft of the survey was created in Adobe Illustrator, and was later on revised in Adobe InDesign in order to make the file an interactive PDF. Reasoning for this was that not all respondents were able to directly fill in the survey and some had mentioned to have lost it and requested a new online version. Therefore the explanation stayed face-to-face, however by also emailing the respondent the researcher was ensured that the respondent had a copy of the survey at all times. The interactive PDF allowed respondents to fill in the survey on their way home on the train or in-between meetings on their laptop.

4.3 Expert Panel

After comparing the outcomes of the case studies and survey, a conceptual model for the added value of agile project management in early project phases of the construction industry was developed. In order to identify the applicability of the model in the construction industry, an expert panel was developed. The panel consisted of experts in project management. A session was organized in which they were able to evaluate the model and identify areas that were unclear and also discuss how the model could be improved to become applicable to the construction industry.

4.3.1 Expert Panel Set-Up

The set-up of the session can be explained in three different parts. Firstly the researcher provided the experts with a presentation about the results of the research and an explanation of the conceptual model. Following, the experts were asked to individually fill in a survey about the model and answer the discussion questions with appropriate argumentation. The survey can be found in Appendix E1. Lastly, the majority of the session was based on the discussion of the model between the experts.

CHAPTER 5
Results & Analysis

5. Results & Analysis

Apart from the literature study, it was important to collect data from interviews and the surveys in order to be able to analyze the (added) value of agile in the construction industry. The interviews were conducted in a semi-structured manner for twenty-two respondents and eighty-seven respondents completed the surveys. The number of participants necessary to interview and fill in the survey was decided on through literature in the research set up. Literature stated that the broader the scope, the more information needed. The nature of the topic also matters - if this topic is clear and generally well-understood, less participants will be needed to reach a saturated result (Morse, 2000). As six exploratory interviews were already conducted, twenty-two respondents from five different case studies were sufficient for current practice analysis.
Firstly the individual case study results will be discussed, followed by a cross-case analysis. Following, the survey analysis will be discussed. The set-up of both these data gathering methods has been discussed in the previous chapter. Furthermore, the analysis of both the interviews and surveys will lead to the development of a model, which shall be presented in the expert panel chapter.

5.1 Case Study Results

As the literature study also acknowledged, little is known about the implementation of agile in the construction industry. Therefore the analysis of the case studies will explain the current practices in infrastructure projects and discuss their project and process value. Moreover the problems in project management will be discussed to form possible opportunities for agile project management implementation. As the case study results were rather extensive some of the results such as the discussion with the respondents about which elements of agile could in their vision work for current practices and which elements will not work, was moved to the appendix (See Appendix C1-C5). The general set up of each case study result description will start with some general information about the case studies followed by the most evident results of value management and project management.

5.1.1 Respondent Characteristics

As stated in the case study set up, a minimum of four respondents was interviewed per case study. The table below identifies the characteristics of the interviewees. As the status of some of the projects is different from each other, the first column on the left indicates the project status. The next three columns provide some the basic case study interviewee information, followed but the roles of each respondent. Next the column devoted to educational background states the highest educational degree each respondent has completed. Lastly, the most right column indicates the number of years of experience each respondent has.

Status	Case Study #	Company	#	Project Role	Educational Background	# Years Experience
Early Project Phase Finished	1	W+B	1	Project leader sub-team & advisor	MSc. Civil Engineering	7
		W+B	2	Project leader sub-team Ecology	MSc. Biology	16
		W+B	3	Specialist environmental law	MSc. Dutch Law	20
		W+B	4	Project leader Hydraulic Engineering	MSc. Hydraulic Engineering	16
Early Project Phase Finished	2	W+B	5	Project manager	MSc. Civil Engineering	18
		W+B	6	Project leader sub-team	MSc. Civil Engineering	13
		W+B	7	Assistant Technical Manager	MSc. Civil Engineering	10
		W+B	8	Project Manager	MSc. Biomedical Engineering	9
		W+B	9	Assistant Plan Study Manager	MSc. Planology	11
Early Project Phase Finished	3	Arcadis	10	Principal Consultant Value	MSc. Civil Engineering	27
		Ganto	11	Sub-Contractor Principal Consultant	MSc. Economic Geography	21
		RWS	12	Project Manager	MSc. Civil Engineering	9
		RWS	13	Project Manager	HBO History Teacher	18

Second Phase Early Project Phase Running (10/17)	4	Arcadis	14	Project Manager	MSc. Business Administration	19
		W+B	15	Project leader	MSc. Hydraulic Engineering	21
		Arcadis	16	Project leader sub-team	MSc. Country in the Directional Sciences	16
		W+B	17	Project leader sub-team/ specialist	MSc. Civil Engineering and Management	5
Early Project Phase Running (10/17)	5	W+B	18	Project Manager	MSc. CME	3
		W+B	19	Project leader	MSc. Biology	10
		W+B	20	Technical Manager	MSc. Civil Engineering	15
		W+B	21	Project Leader Design	MSc. Landscape Architecture	10
		W+B	22	Contract Manager	MSc. Civil Engineering	14

Table 25: Respondent characteristics case studies

5.1.2 Results Case Study 1

This case study was completed the longest time ago from all of the other case studies, namely in 2016. However, within the company this case study is well known and viewed as an example project as it was one of the first projects where changes were implemented in the project process approach. Aspects of a more flexible approach in terms of planning were applied, and experienced pleasantly. Since this project employees are increasingly interested in a more flexible approach especially in terms of planning. Likewise for agile project management the methodology identifies stand-up meetings and project rooms, this project was of interest to the research. Firstly a short project description will be provided, followed by the project management methodology, and lastly the results, which have been transformed into statements regarding current practice and agile implementation. A more extensive description of all of the results can be found in Appendix C1.

Project Description

The case study is a 32-kilometer long dike. Additionally, on the dike a highway is positioned. The dike was constructed after the heavy storms in 1916 when several dikes around the Zuiderzee broke through. The construction of the dike started in 1927 and was completed in 1932, making a large part of the Netherlands a lot safer. Thereby making the dike an icon for the Netherlands that is visited by many tourists each year.

In 2006 when safety checks were completed, the results showed that the dike needed safety improvements to keep the backcountry safe in the future. After seventy-five years, the dike needed to be refurbished. The refurbishment is due to increasingly strict safety regulations as well as rising sea water level (and also higher peaks of water drainage). Therefore the dike should not only be made higher and reinforced in order to withstand the sea in the most extreme conditions, but also be able to adequately spray excess water from the rivers if they are experiencing extreme amounts of water supplies.

The main aim of W+B is to achieve safety for many areas in the Netherlands and make sure this safety is sufficient at least until halfway this century. In order to do so, the dike must be made overload resistant, the locks must be strengthened, and pumps must be installed in the spray complex. In 2013 the plan study of the case study started and was divided up into four main phases which all took up a minimum of six months. In total this project phase was completed in 2016 (therefore a total of 3 years). Within the original scheduling of the project, an acceleration of two months was encountered in the last phase. However, as previous phases also encountered small accelerations – the project was completed within the timeframe as planned upfront.

Project Management Methodology

The interviewees stated that no particular project management methodology was applied to guide the entire project. Instead, the respondents mentioned that this was the responsibility of the core team. The project leaders and specialists outside of the core team completed the tasks that they were given. One of the respondents mentioned that the approach should not be seen as unprofessional, as the project team was definitely able to improvise when necessary. Thereby meaning, methods were applied when necessary. For example lean aspects were used in certain

phases of the project. In order to be aware of how to use aspects of lean, trainings were completed.
One of the interviewees stated that the IPM roles were applied to establish their project organization, as this was the preferred method used by the client. Each role on the side of the project team also had a counterpart in the client's team.

Most evident results value management current practice
The outcomes of the four different interviews have been analyzed and will be made concise into the most evident results of value management in current practice. The resulting statements are provided below. The statements are provided in bold with an explanation below.

1. **Value in projects is achieved when the aim as discussed upfront is realized. Added value is everything completed above the expectations as determined in the beginning of the project.**
   All respondents recognized that the aim of this project was to make sure that the dike was restored in time in order for the environment in the area to remain safe. Next to the safety, the dike is also very well-known nationwide as well as for tourists. Therefore not only the residents and road users would be faced with problems if this value was not achieved, but it will also be important to all the tourists heading out to the dike. All respondents replied to this part of the research in the same manner, by identifying the definition of value as the goal of the project.

2. **By collecting wishes from both the client and the residents surrounding the project environment, one can determine the value that will need to be delivered.**
   Most respondents mentioned that within their discipline it was within their influence to make sure value was delivered. Thereby indicating that their view on value is mainly focused on the project outcome, and not necessarily also on the process or within a project phase.
   Making sure the correct team was working on the project with necessary knowledge was recognized as one way to make sure value was delivered.

3. **Defining and controlling value is important and implicitly completed when the interests of the different parties are discussed.**
   All respondents considered defining and controlling value to be important, but on the other hand something that is explicitly measured. It is important to know the interests of the client; therefore this was certainly discussed during meetings with the client. In addition to the meetings with the client, internal weekly stands (when necessary in the project) were organized to make sure people knew what they needed to do and who their products needed to be passed on to. Additionally, who would be waiting or delayed in case this was not completed.

4. **A value engineering session is a possible way to make sure value is delivered and controlled throughout projects, if completed on a regular basis.**
   Only one of the respondents mentioned value engineering sessions during this part of the interview, others related to value engineering more in the way of being part of discussions during meetings. Consequently, as the value engineering session was only organized after being a year into the project, the coherent applicability of the methodology is questionable. One respondent identified to be unsure why a year was waited before the value engineering session was organized. Additionally the respondent also mentioned that the session could have been useful, but as it was only organized once – its influence was minimal. The respondent mentioned that during the session the team members discussed the activities they were involved in and the aim of the activities, as well as who would like and will need to receive the products from each other. Another respondent mentioned that value management was not necessarily the focus in this project; instead the focus was rather on lean management. Nonetheless the above statement explains that the value engineering sessions are a possible way to deliver and control value.

5. **Value in projects is found by achieving the project aim within the time, budget and requirements, whilst value in project processes is found in the project scheduling approach, efficiency and teamwork. Even though there is a difference, there is a certain tension between value in projects and processes.**
   All respondents clearly stated to identify a difference between value in a project and value in project processes. The respondents identified the differences through the criteria as stated above. The answers of the respondents indicated that the value of a project is identified more in terms of hard skill factors whilst the value of a process is identified more in terms of soft skills. The process can be inefficient if the different stakeholders in the project have different opinions about the project approach. This can be internally for example when within a project team - members have a different approach for completing a task, or this can be externally with the client. Both ways can obstruct the process and cause miscommunications or products that do not live up to the interests or requirements of the client. Currently, the process of projects is measured in a more implicit manner, therefore making it difficult to determine what the differences in efficiency and smooth running of the project would be if more focus were to be dedicated to the process.

6. **Not all employees are trained and know how to apply particular project management methodologies as can be suggested for the project.**
   One of the respondents mentioned that W+B has many specialist employees and less employees also trained in the project management, verification and validation and system-based contract management. Therefore outside of the actual design of the project, many steps can still be taken. By training employee's prior or during a project they will be able to implement the discipline more appropriately. By combining the trainings with projects, employees will get a feeling of how to implement the methodology.

7. **It is difficult to determine how to achieve maximum value in projects, as work for products is often completely parallel to each other.**
   One of the respondents mentioned to be unsure of maximum value in projects because employees are requested to work together with many different disciplines in a short period. Due to time pressure, products are often realized parallel to each other. The respondents' solution to this drawback would be to organize projects more in terms of different design cycles in which together the team discusses how to reach maximum value and how this is achieved together. Another respondent also mentioned that it is never enough to keep asking yourself if you are doing the right thing and what you are doing is actually necessary.

8. **Focusing more on the management of project processes in terms of teamwork and communication will increase value.**
   The respondents mentioned that most of the time the philosophy is often that the content is what will sell. However, when people are lacking to ask themselves if they are doing the right thing and who will need to use their products in the near future, efficiency can lack in the project process. Everyone, especially specialists, should be asking themselves these questions. Mostly this can be changed through individual motivation throughout the project. Additionally this can be created by focusing more on the team (by for example hiring a team coach as done here) and including individuals more intensely in the project process. For example fifteen team members on a weekly basis completed a weekly stand. This included the core team and several project team leaders. However, within the specialist teams, weekly stands rarely occurred.

Most evident problems project management current practice

During the interviews problems encountered in the project as well as generally in projects were discussed. The main results of the discussions are displayed below with a short explanation.

1. **Difficulties in finding the right people for the project, who also fit well in the project team.**
   As all projects start and finish at different times, it is often difficult to determine who is available to ask to join the project team. Additionally, it is important to know if the

employee will also fit well in the project team. As not a lot of time is usually spent on finding the correct people (as this is considered to be very time consuming, and this time should be spent on other activities), employees often ask people within their own network range with whom they already have experience or they know.

2. **The client often consists of more than one person. When products are audited, this often results in different opinions on the work delivered.**
   As the client often also has a counter team to the company's own project team – this means that more than one client is involved in the project. Therefore when reports or other products are provided to the client(s) and returned with feedback, the feedback is often not coherent. When the clients have different opinions, it is difficult to decide on which feedback the project team should focus and which changes should be followed through. Therefore the requirements are often unclear. A possible solution to this issue could be to take more time to involve the clients throughout the process.

3. **Often not enough project time is spent together with the team at the same location.**
   One should be flexible to also travel to location. This of course is only possible if there is an adequate project room and enough tables and chairs for all employees to be able to work there. However for this project there was enough space in the project room, except people still tended to work at their own offices. Respondents agreed that if you do not see each other often enough in the project then this can become a drawback.

4. **Last-minute changes are often requested, which result in a field of tension between time and quality of products.**
   Often last minute changes are requested. At this time it is very difficult to still follow these changes through at the appropriate quality and also within the time available. A lot of the time the project team will focus on delivering on time, but will thereby not be living up to the original quality as set. Of course this is something that is preferably avoided, and therefore more focus should be set towards change management.

5. **Often the project team is not provided with proper documents, influencing the quality of products.**
   Sometimes parts in the documents of the status of the environment to be analyzed are missing, or certain sections in reports are not included, or incomplete. This makes it difficult for project teams to be able to complete the required products up to the quality as also required. If one does not have access to proper documentation then the work will also be of less quality.

6. **The different languages used within projects often cause miscommunications.**
   People are often speaking different languages within the same project. Meaning the same terms are used but something different is indicated. This causes a lot of products to be sent back and forth between employees because people do not always understand what is asked. When people work off-site then this is increasingly difficult, as it will also take longer to ask someone what they meant. Additionally people might also not wait for answers but simply interpret things in their own way.

Most evident opportunities project management current practice

Likewise, the results of the interviews have formed the statements below that indicate the opportunities in current practices. The statements include a short explanation.

1. **Encourage people to also identify a project day for each specialist discipline next to establishing a project room.**
   The current offices definitely allow for enough space available to establish project rooms. However as most of the time employees are working on more than just one project at a time, often people still end up working outside of the project room in order to fit their agenda's. Therefore within each specialist discipline it will be advised to organize a project day once a week, when everyone works at the project room. If more than one day per week is spent on the project, it will be fine to sometimes work at your own office. However the face-to-face communication at least once a week is important to keep everyone working on track and aware of each other's products and progress.

2. **Make sure enough time is dedicated to getting to know each other in the project team, by for example organizing a proper project start up, and follow up, as well as informal meetings.**
   Often not enough time is spent on getting to know each other and also the organization of the entire project. By making time to get to know each other team members will also be more aware of the things that motivate the members. This starts off with a project start up. However, apart from these formal meetings, make sure that there are also informal meetings. This could result in more trust between project members as well as people feeling more comfortable around each other. By feeling more comfortable around each other, employees will be more likely to criticize and help each other throughout the project.

3. **In addition to sending or discussing sub-products to the client(s), it will also be good to receive internal interim feedback.**
   Often before the product is sent to the client(s), a second reader approves the product. However, by letting the auditor read the product just before sending it to the client(s), the auditor will have less influence. By including the second reader right from the beginning, chances are that less will need to be altered at the end. Therefore less rework will be necessary once the document is completely finished.

4. **Hiring a team coach who focuses on training employees in more coherent communication in projects.**
   As mentioned previously, miscommunications are often established in projects. Often this is due to the use of language that differs per person. The interpretation of terms will also be different for each individual, sometimes resulting in potentially unnecessary reworks. By training employees, people will be able to understand each other more properly as well as each other's goals and ways of working.

5.1.3 Results Case study 2

This project was the second case study, although the interviews were completed as one of the first. A project description will be provided, followed by a description of the project management methodology of this particular project. Following the evident results from the case studies regarding value in projects and processes will be provided as well as a discussion of possible drawbacks and opportunities. In Appendix C2 a more in-depth overview of the case study results can be found.

Project Description

This highway project will be transformed from three to four lanes in each road direction as well as a changeover lane. At a particular location around Amstelveen the highway will be deepened 1.3 kilometers. With two overlays the Amstelveen South and North will be connected. Additionally around Oude Dorp and Stadshart the road will be covered and at other places along the road noise shields along 12 kilometers will be placed. These noise shields were not originally in the project description but were accepted after quality incentives were requested.

The deepening of the highway was not part of the original plan, as this was to develop a tunnel. However due to the economic crisis the original plan was no longer feasible and new exploratory research had to be completed. This revised exploratory research was completed by Witteveen+Bos and resulted in the best and also selected alternative, which was the deepened road. Additionally a bridge will be developed for bicyclist and pedestrians, whereby the total viability of the area will be improved.

The early project phase was completed in the beginning of 2017 and took a total of 2,5 years. The total project is predicted to complete between 2024 and 2026.

Project Management Methodology

The respondents all recognized that no specific project management methodology was applied during the project. However, all respondents did distinguish BVP and lean elements in their project management practices, however only aspects were applied.

Most evident results value management current practice

The outcomes of the interviews have been analyzed and will be made concise into the most evident results of value management in current practice. The resulting statements are provided below, including a short explanation.

1. **Value in projects is generated when demands of a project are fulfilled. Added value is created when optimal solutions are unraveled that exceed the client's expectations.**
   All respondents considered the value of projects to be found in the final outcome of the project and the client's reaction. By completing the project and living up to all the demands as requested by the client, value is created within projects. However, if extra solutions are developed that interest the client, added value will be created. This initiates creative thinking, which is also developed when applying BVP. For this project noise reduction shields were developed in return for incentives. This resulted in both W+B and the client to be satisfied as we were able to establish a solution that broadened the scope of the project but drastically minimized impact on the environment.

2. **Value can be identified during value engineering sessions and delivered accordingly by continuously auditing for correct scope accomplishment.**
   In this project value engineering sessions were completed during the earliest phase of the project. The client was also involved in this process. This allowed establishment of demands and expectations and ensured that the right values were incorporated in the design. Additionally in order to maintain the vision on value and continue to incorporate it, continuous auditing should be completed. During this project this allowed everyone to be actively involved and made everyone aware of each other's choices.

3. **Value is implicitly controlled, but stimulates engagement in project challenges and opportunities. If this ambition is recognized, participation problems will be minimized during later project phases.**
   There is no control tool or method that is applied to regulate value. Nonetheless all respondents recognize that this is an important aspect of projects. Even though value is implicitly controlled, it allows the employee to develop an ambition during a project that creates a solution for society. However if value is not controlled most probably the project will still be completed, however the project challenges will eventually fade as you are not taking on any opportunities. Additionally if you do take on opportunities and this is recognized during the project, you will be faced with less participation problems throughout the project. This was also encountered during this project as solutions were proactively searched for as well as early on alternative designs and studies to be able to decide upon a design that was well thought through.

4. **An adequate focus on project process is able to establish added value for the final project.**
   A difference was noticed by all respondents between value for the project and value for the project process. By involving the municipality actively in this project all interests were accurately considered throughout the process whereby eventually a lot of additional value was created for the project. Process value is recognized in the agreements made and the uncertainties actively being tackled. By ensuring that no rework will need to be completed through miscommunications or misinterpretations, the process will lead to a highly valued project. For this reason, in this project the entire scope was also split up into three different phases to ensure that the project endured its simplicity and everyone was able to keep up and understand all process steps.

5. **Drawbacks in value delivery are found in client relations and lack of proactive interference in decisions made by the client.**
   Changes within projects can only be made in accordance of the client. The client will always have to accept new ways of working, for a certain method or change to be executed. During this project more interference should have been completed with the client as W+B realized certain actions should not have been completed. As this was not done properly unnecessary risks we established. One of the respondents stated it should have been W+B's task to advise the client more properly. The lack of advice can possibly

also be traced back to the formal relationship with the client in this project. Agreements are set up front, but throughout the process more informality could lead to a better and easier understanding of each other's demands.

6. **Opportunities for optimal value delivery are found in improved methods of communication.**
   A lot of the client related issues are improved through improved communication and possibly also through more informal behavior. Additionally in this project some of the risks identified in the project were not properly communicated to everyone. A different approach to communicating risks can also be by communicating important aspects from a directory level. Then maybe more people would have been aware of the risks.

Most evident problems project management current practice
During the interviews the problems encountered in the project as well as generally in projects were discussed. The main results of the discussions have been summed up below along with a short explanation.

1. **People can be advised to change and follow a new methodology, however it is in their nature to go back to methods in which they feel comfortable, once they are no longer check up on.**
   The attitude of project members can be an issue. Employees should have the same mindset or at least be flexible to work in a different mindset for proper teamwork. Another problem with attitude was recognized in this project as the core team only provided the rest of the team with updates when they considered updates to be important. This decision was made in order to reduce the number of communicated hours; however the downside was that employees became less motivated. Sessions should continuously be organized to update every team member.

2. **Different ways of documenting and use of language causes confusions and misinterpretations.**
   Everyone is used to the way they work and also prefer the way they work. However if there are no rules in the language used and also the way the project will be documented, a lot of confusion will be established. All documentation should be more accessible and more transparent.

3. **Communicating updates properly and to the right people.**
   Spreading information and updates always happens, but distributing the right information to the right people is very difficult. Within the core team the right information was shared but especially within the sub-teams it was difficult to communicate effectively.

Most evident opportunities project management current practice
During the interviews the opportunities encountered in the project as well as generally in projects were discussed. The main results of the discussions have been summed up below, including a short explanation.

1. **Continuously organize sessions to update all team members.**
   By finding a particular moment each week (or daily) in which the project members are updated about the project progress is extremely important to keep all members on track and motivated.

2. **Take enough time for project start up in order for all members to properly get to know each other and feel comfortable around each other.**
   In order for people to correct and also help each other they will need to feel comfortable around each other. By approaching each other as colleagues and getting to know each other, employees will be able to excel in operations. Also, everyone needs to have the right mindset and have an open attitude.

3. **Establishing periodic audits also at a team level.**
   Both internal and external periodic audits will allow people to be aware of each other's worries and how the project is going for everyone personally. This would fit at the end of each project phase. This could possible help people's motivation and mindset.

4. **Making people aware of their responsibilities and also for the bigger picture.**
   Delivering together is only possible if you live up to the requirements together. Employees should feel responsible not only for individual responsibilities but also for the bigger picture. A solution could be to organize more sessions that update the entire team on a regular basis.

5. **Encourage employees to take initiative.**
   This again relates to an attitude manner. By often involving people who are not part of the core team in the progress and changes of the project, people will become to feel more involved and more motivated. Currently, people outside of the core team sometimes do not feel the need to become involved even though they might want to express their opinion. To a certain extent this should be encouraged more, in order for all employees to also want to become more involved in the process.

5.1.4 Results Case Study 3

This case study is the only completely external case. The case study was chosen through the special interest group of DACE, which is the Dutch Association of Cost Engineers – and since recent years also Value Engineers. A project description will be provided, followed by a the evident results from the case studies regarding value in projects and processes as well as a discussion of possible drawbacks and opportunities. Appendix C3 provides a more in-depth discussion of the case study results.

Project Description

In 2008 a program was developed for all the bridges in the Netherlands that needed to be renovated and endured the same type of problems. As most of the bridges in the program were all built around the same time, they were also all slowly becoming insufficient for use. A solution was proposed for the bridges in this program, namely a high strength concrete renovation. As experience in this renovation technique was lacking, the first bridge was considered an experiment where one could learn from along the way. Once the renovations started, several additional problems were revealed that could no longer be resolved through a new high strength concrete layer. If continued, the concrete for this specific bridge would have made the bridge too heavy meaning that the bridge would need to be reinforced at many places. Hence this became an impossible solution, which meant another solution had to be developed.

The bridge will not be sufficient anymore in 2020 and will need to be closed if no alternative is established. This will have major implications for the transport traffic in this area, and is simply not an option. Therefore the exploratory phase was repeated, which resulted in many overruns as the entire scope needed to be changed. Currently, two solutions have been established - a short and long term solution. A temporary bridge will be established along with renovations of the current bridge. Therefore, this project has been split up into two projects. The renovation of the current bridge has completed its early project phase and will be taken into account during the case study interviews.

Project Management Methodology

All respondents identified the IPM model as the project management methodology. The methodology originates from the clients 'side. The model entails five processes: project management, risk management, environmental management, technical management, and contract management – along with five key roles for each discipline. The respondents identified the model to be similar to PRINCE2. It involves multiple workflows where collaboration is key, the required input is the requirements of the stakeholders and the output will be the contract.
In addition one of the respondents mentioned to have adapted lean elements during this project. Furthermore, respondents stated that lean has become a more familiar project management methodology and is starting to retrieve a position in the standard management guidelines for projects. Agile hasn't reached this position, however respondents mentioned that visual management and Kanban method is starting to be used slowly.

Furthermore one of the respondents mentioned that value engineering sessions was adopted in order to discuss the process approach for the project.

Most evident results value management current practice
This section will provide a summary of the four interviews and the main outcomes regarding value management in current practice. As the case study set-up also mentioned, all respondents were asked the same questions. Their answers have been transformed into statements with a short explanation below.

1. **Value of this project is found by simplifying and clarifying the scope towards a feasible project whereby all economical transport will be able to remain to travel.**
   As one of the respondents mentioned the value within the context of this project is found by simplifying the scope towards a feasible project. The other respondents replied that the importance of this project is that found in traffic management. The economical transport of the Netherlands should remain to travel over this bridge. All of the company activity and economic happenings at this area are dependent on this bridge. Correspondingly, all respondents have identified solving this issue to be the value of this project.

2. **A value engineering session delivers value and is based on interventions, accelerates the process, and improves interfaces. Moreover the sessions are best performed in early phases of projects.**
   Already in the early project phase the value engineering sessions allow value delivery. The strength of the sessions is the workshops where different stakeholders consider the future of the project together – what do we want and how do we make sure we get there? One of the respondents mentioned the differences between scrum and the value engineering sessions – scrum was more continuous and the value sessions more based on interventions. Additionally another respondent added that the value engineering approach secured all requirements of important stakeholders. Throughout all the studies and different scenarios completed for the project, all the important parties (representatives of the parties) were involved. Thereby in a sense controlling the value.

3. **Defining and controlling value is extremely important in order to prevent dilemmas in later project phases (i.e. political).**
   By organizing the value engineering sessions, value was identified. Controlling value is important as later on in a project value can change again due to many different factors, for example politics. In order to prevent political dilemma's, timing is very important and the scope of the project should be clear. The respondents correspondingly elaborated on the political factor, as bridges are considered very huge within political management. The correct maintenance of bridges is considered very important, as this is one of the driving forces in the economy.

4. **Project value is result-driven and the process value of projects is related to the way your get to your project result. Nonetheless the value of a project is often created during the process.**
   All respondents recognized a difference between value for a project and value for the project process. The value of a project is often created during the process. For example right at the start of a project it will be difficult to state the value of the project, as there will not be anything tangible. At this stage the value of the process can be stated. The value in projects is result-driven; however the way you get to your project result should also be considered to be very important. The two types of value cannot be considered separately as together they form the value of the complete project. Once you spend enough time on the process and take the time to get going and set everything up properly, only then you will be able to accelerate to a higher speed appropriately.

5. **A drawback in value delivery is found in fear of negative judgement.**
   All respondents recognized the difficulty of this project, as the bridge should have been renovated years ago. However as this is not the case, there is a lot of time pressure currently. The connection with high economic importance can become at risk if a solution isn't established soon. When time-pressure is important for a project often the

window of opportunity to innovation becomes smaller and smaller. It requires guts and ability to still work in a different way under these circumstances. From experience, one of the respondents explained that fear is the reason for not delivering value. Fear in relation to political negative judgements for example and not retrieving the money necessary for the project. People are scared to make mistakes and take risks, as they are scared to be judged.

6. **Opportunities in value delivery are found in making people more aware of lost and added value in projects.**
   The solutions can only be found if they are thought of together. By discussing which aspects of projects can really add value and identifying control management techniques, people will become aware of the potential of a project. Additionally, one of the respondents mentioned to also need to focus on the lost value and make sure people are aware of the inefficiencies in a project in order to minimize them. Make sure this is clear to people and they are aware of them. For example one of the respondents mentioned that we often think we know what politics find important, but we will only know for sure if we are able to establish the value together.

Most evident problems project management current practice

The next section of the interviews asked the respondents to identify problems endured in project management in current practices. The results of the identified problems have been summarized into statement, provided below. All statements will also entail a short explanation.

1. **Information management in projects is often a problem as the information provided is often not current, reliable or complete.**
   One of the respondents referred to the ABC in Dutch, relating to information not being current, reliable, and/or complete (ABC). This is often the case for projects, making it difficult to analyze the current situation and discover opportunities as well as risks. If the project team isn't sure of what is out there it will be difficult to estimate the functions and how long they will stay reliable. Appropriate information management is very important to allow the project team to develop an appropriate project.

2. **Tracing documentation of products is often an issue. Files are often located in different folders.**
   Often people will have their own ways of working. Hence employees will tend to save and organize project folders within their own discipline and in their own ways. This has caused some problems in the past as a different organization of folders in each discipline makes it difficult to trace documentation. Especially as employees will mostly not be working fulltime on projects, sometimes another team member will need to find a particular document on their own if their colleague is busy. This can take up unnecessary chaos and time. An opportunity would be to find a way everyone should organize their documentation and make sure people are also living up to these suggestions.

3. **It is difficult to find the right people for the project team.**
   Often within teams there isn't enough room to establish a perfect team. Generally teams are always based on people who have time to engage in the project. Two of the respondents mentioned it to be important to spend more time on looking for people who are also a good match in the team. This is often a subject of discussion, but in practice never happens.

4. **Project team members often work off-site at their own offices (also due to lack of workspaces).**
   The entire project team is often very large. For all of the members to be able to work at the same location at the same time is often very difficult. However, most of the time there isn't even enough space for sub teams to work at the same location. The project room often does not have enough workspaces. Therefore a lot of people tend to work at their own offices. This distance is a problem as people will continuously be unaware of all the project matters and the teamwork will also become more difficult. One of the respondents also identified the need to be stricter about the days people should work at the same location.

5. **Most of the organizational culture is still quite traditional and conservative, making it difficult to change.**
   The traditional culture of the building industry remains a masculine culture, which is loyal and hardworking but also very conservative. The conservative aspect of the industry can make it difficult to change. One of the respondents stated that this culture has elements that prevent changes from occurring. The culture should allow more changes, renewal, trust and openness with each other. This conservatism is found both within the organization as well as the way the project team interacts with the stakeholders.

Most evident opportunities project management current practice
The following section summarizes the results regarding opportunities in project management in current practice identified by the interviewees. The results have been summarized into statements along with a short explanation.

1. **Establish shorter delivery cycles and sub-deliveries to enable more feedback throughout the project.**
   Project teams should better and also more clearly define deliveries as well as establish expectations. In this way members will be certain of what should be delivered and when there is also space for changes. Short deliveries as well as sub-deliveries should help enable deliveries that satisfy everyone involved in the project. One of the respondents mentioned that nowadays teams often still establish at the end of a project that they did not deliver as was expected. By changing the way project teams deliver, this can be eliminated/minimized.

2. **Provide incentives for innovative project approaches.**
   When project teams are provided with incentives they might be more reluctant to change when necessary. One of the respondents mentioned that currently project teams are used to extinguish fires and only react when changes are absolutely necessary. Current incentives are provided in the way that being able to have a tunnel ready on time, even if this means being able to finish in the last minute. Current attitudes acknowledge that even if the proverbial fire was only extinguished a few minutes before the tunnel will open, costs are not discussed – as delivery was timely. Contrary when the project team follows steps accurately and provide an exemplary project, no one will hear of the project. This culture is a barrier for projects. One of the respondents mentioned that it would be good to change these types of incentives, and the culture in which they are provided.

3. **Finding the appropriate team of people who are willing to work with the unknown.**
   One of the respondents mentioned that in order to be able to mitigate in unknown situations, the appropriate teams should be established with people who are able to work with the unknown. In the respondents opinion this is best completed with diverse teams, with people who are able to work in different disciplines and thus add to the project using their own unique experiences. Attitude is a criterion that was established by all respondents, as this will be an important in order to be able to change (everyone must be willing to change).

5.1.5 Results Case Study 4
This case study was chosen after the exploratory interviews. The respondent informed the researcher about willingness to implement agile in the project and they current attempts of scrum and lean. Even though the project is still partially running, as this is the first project after the trial attempt to implement flexible management, it was considered too interesting not to analyze. As the first phase of the early project has already been completed, the main focus of the interviews was on the experiences during this phase. A project description will be provided, followed by the evident results from the case studies regarding value in projects and processes will be provided as well as a discussion of possible drawbacks and opportunities. Appendix C4 will provide a more in-depth description of the case study results.

Project Description
From all the case studies, this case study included the most dike reinforcements in one project. In total twelve dikes will be reinforced. The early project phase of the project started up in 2016, followed by the first preferred designs in October 2017. As the project consists of twelve different dike reinforcements, choices were made to firstly deliver the simpler dike designs and spend more time on the more complicated dikes. Hence the last five dike designs will be delivered in February 2018.

The early project phase of the dike reinforcements will be completed through a consortium of W+B and Arcadis. The ambition of the consortium is to make sure the dikes will be ready in 2020 instead of in 2024, as the original planning entailed. There is a high need for improvement water safety in this area as nobody wants the flooding from 1993 and 1995 to repeat. However chances are increasingly becoming more realistic due to climate changes. The weather is becoming more extreme, and more rainfalls that rely on the area to drain more and more water. As the dikes have remained the same whilst the climate changes are increasingly becoming more alarming, something must be done. The new designs must think ahead and act on time in order for future generations to be able to safely live in the area of the project.

Project Management Methodology
The respondents identified no particular project management methodology for this project. Instead, one of the respondents replied that everyone within the project is able to manage it in their own way. After having said this, the respondent also mentioned that this could be a drawback for the project as there is no specific project manager managing the risks of the project and being responsible for everything. Two other respondents have added to this by explaining that the IPM roles (as also explained in the previous case study) were used to describe the project roles for the core team as well as the cluster teams. Nonetheless, in general the main approach applicable to this project was to do what the clients wanted and consider how this can be achieved.

Most evident results value management current practice
In this section an overview will be provided of the most evident results from the four interviews for this case study regarding value management. In order to summarize the results collected in the interviews, statements will be provided that display the main results, followed by a short description of each statement.

1. **Project value is found in the realization of the project within budget and planning.**
   The respondents identified the value of projects in terms of finishing the project within certain limits as discussed upfront – mostly relating to the budget and timescale. Most of the value can be found in delivering deliverables on time. Within the project value the project team strives to execute the project in an optimal way for the project itself and also for stakeholders surrounding the project environment.

2. **In the case of very complex projects where changes occur daily, value is delivered in the short-term sense by going with the flow. There is only structure for the main milestones in the long-term sense.**
   Currently structure is missing in short-term working approaches and deliverables. One of the respondents mentioned that as a project manager the respondent would prefer more structure and have project team members follow steps and really think about the steps they are will take. As the project is very large and also changes daily, experience has learned that it is very difficult to structure this. For the long-term there are certain milestones in the planning that need to be completed. This is the only type of structure there is for delivering critical deliverables. Another respondent added to this explanation by explaining that by lacking short-term structure the team often focuses less on quality if this will mean that the team will be able to deliver on time.

3. **Delivering value and controlling value is completed by working closely with the environment and also through involving stakeholders at set sessions throughout the project.**
   In order to be able to deliver value and find a way to control it, the project team will need to know what the different stakeholders value. Therefore the project approach

ensured that the stakeholders were to be involved often. Residents were involved from the very beginning of the project, in order to identify who lives in the area of the project and what their needs are. By taking these needs into account and updating the residents at set times, the project team ensured that there is interface management.

4. **Value delivery and control is important due to social responsibilities and to be able to accomplish the quality as demanded.**
   The project has a social responsibility towards Dutch citizens since the project is financed with many millions of governmental money. Therefore it is important to substantiate every decision and occurrence to the outside world. Another respondent added that if they wanted to make a good return and accomplish the quality demanded, then it will be very important to ensure that the work is structured and the value is determined as well as considering a control mechanism.

5. **Value of projects and processes is interrelated. Project value is based mostly on the level of acceptance of the project from stakeholders whilst the process is focused more on collaborating and communicating effectively with stakeholders.**
   A difference is considered between project and process value, however the respondents identified a relation between the two. The value of projects and processes is interrelated. If you have your process set up correctly then your project will also be completed properly. The difference in value for projects is that it depends on the level of acceptance of the eventual project from stakeholders. The value of processes is found in appropriate focus on collaboration and communication with all stakeholders throughout the project.

6. **There is a difference between value of processes and projects however this is still very new and vague in our projects.**
   Two of the respondents answered to not necessarily be able to identify the difference between value of projects and processes. Both replied during the interview that they would prefer not to answer this question, as the terminology value management was still new to them. During the discussion they acknowledged that there could be a difference between the two but this difference was still too vague for them to be able to define the difference.

7. **Drawbacks in delivering value are found in the high time pressure makes it difficult to deliver the adequate quality of products.**
   One of the respondents explained that due to the high speed of projects and time pressure they often do not have the time to complete the things they need to complete. Additionally, delivering the quality as demanded is very difficult with the high time pressures in projects. One of the respondents added that the time pressure would be less visible in this project if they were given two extra months – then the product quality would increase. Overall there is a visible tension between quality of the contents and the time necessary to complete products.

8. **An opportunity for increased value delivery could be to organize sessions together with specialists and the client and managers directed to discuss team problems, communicative problems or content questions.**
   One of the respondents mentioned that this opportunity was rather helpful in another project. By organizing sessions where the specialists also had a say, they will feel more included in the project and will understand the importance of their specific product for the rest of the project better. Additionally, miscommunication and insufficient deliveries can be minimized, as during these sessions they will be able to ask their questions and express their concerns directly to the client. Another respondent also agreed that the link between specialists and the client is often lacking, and it would be an opportunity to find a way to also include specialists more in the bigger picture of a project.

9. **Opportunities in value delivery are found by spending more time and sessions on interfaces between important products.**
   This particular project is very large, making it important to identify interfaces and manage these. More attention should be consumed on the interfaces. All of the products should be well connected. One of the respondents mentioned that sub-products also

need to be used by other clusters, or information will need to be added from another cluster. This is often not completed correctly. In final texts of products there is often different information about the same sub-product. This should be checked more accurately.

Most evident problems project management current practice

This section explains the most evident problems endured by the interviewees in current practice. The interview results have been summarized into statements followed by a short explanation.

1. **Often the question behind the question is not answered leading us to frequent reworks.**
   One of the respondents mentioned that it is very unlikely not to receive any remarks from the client once delivering a product. However, often the question behind the question is not answered. People will often provide their own opinions on deliverables, which can also mean that products are interpreted differently. Currently the respondents are often receiving unsatisfied remarks from clients, which mean reworks will need to be performed. By discussing the question behind the question together, each team member will develop a better view of the expected.

2. **Within the team, members often share a different scope vision due to lack of scope monitoring.**
   Often at the start of a project the scope is identified followed by project teams fulfilling their jobs by completing their products. However, one rarely asks if the scope is also clear to all team members and if they really understand what needs to be done. Often people will have their own visions on the scope. The scope must be monitored to see if people are viewing the scope in the same way.

3. **Sometimes we cannot influence the clients' involvement if the client does not have the time to join team sessions.**
   There are two reasons for clients not joining team sessions if they are asked to join. The first reason is that meetings are often changed to different times. Therefore last minute changes can mean that the client also has different appointments that cannot be rescheduled. Another reason is that the client can be very busy with other activities also meaning that they will decline as they do not or cannot make extra time to join the sessions.

4. **Team members often work at their own offices.**
   Often even if there is a project room for the team, members still work at their own offices. One of the respondents mentioned that this is due to there not being set times to meet every week or that there isn't enough space to always work in the project room. Therefore people often do not want to take the chance if there is enough room, and prefer to work at their own offices. Another reason could be that employees are not used to working in project rooms and will need more guidance on how to arrange this properly in order for the space to be available and sufficient at all times.

5. **Schedules are often tight, which makes it almost impossible to follow it accordingly if changes occur.**
   From experience, project planning's are often arranged very tightly. This makes it difficult to follow through with changes for products. Especially if they are not calculated in the time buffers, it will almost be impossible to still follow through on the original planning. The interfaces within the planning should be more accurate in order to try to be able to cope with the chances once requested upon.

6. **As a project is full of uncertainties and changes, the right people for the project teams should be found that are able to handle this.**
   The attitude of people is sometimes not correct for what the client is demanding. Often we are asked for last minute changes under time pressure. In order to give this a proper chance and try to finish the products on time, the right people should be part of the project teams. People who are open to changes, last minute extra hours, and have the

skills to keep the chaos out and focus on what needs to be done in order to deliver the product accordingly.

Most evident opportunities project management current practice
Apart from the problems in current practice, the respondents were also asked to identify certain opportunities. The results of the interviews have been summarized into statements with a short explanation.

1. **Indulge more efforts into good teamwork.**
   By taking more time to focus on the teamwork, the process of the project will possibly run more smoothly. One of the respondents mentioned that for projects the client as well as the internal team often attaches great value to positive collaboration. In order to finish a nice process the project team will need to work together more and also write the method of approach, description of effects, and solutions together.

2. **Spending more time on spreading updates and information to the project team.**
   Often information is not spread at necessary times. People will often either discover updates of the project through other employees or simply miss an update and use a wrong version of a document. By sending out a weekly email update explaining current issues in the project, everyone will be aware of the difficulties (or things that are going well). Additionally, every two to three months a project update meeting should be organized which should be compulsory to attend for all project members.

3. **Taking more time to determine the project requirements and expectations together.**
   As miscommunications are often a problem in projects, it will be good to take more time to determine the project requirements and expectations with the entire project team at the beginning of the project. By taking more time at the beginning of a project to clearly determine what will be expected, people will be aware right from the start.

5.1.6 Results Case Study 5
This fifth project was also established after the exploratory interviews. During these interviews one of the respondents explained their first attempt at flexible project management where aspects of lean and scrum were implemented. The case explained during the exploratory interviews failed and was not completed in a proper manner. Therefore that project was not suitable as a case study. Nonetheless a lot of the same employees were engaged in a new project, being the fifth case study, which started up in May 2017 and will complete its early project phase in October 2017. Initially the researcher was hesitant whether to use this project as it would be difficult to reflect upon how to project performed and how the value criteria were measured, as well as recognition of agile elements throughout the project. Nonetheless, this project also provided opportunities. For example, the researcher was able to attend design meetings and stand ups and first-hand experience current practice and evaluate the problems encountered when applying certain agile aspects.

Firstly a project description will be provided, followed by the evident results from the case study regarding value in projects and processes, as well as a discussion of possible drawbacks and opportunities. Appendix C5 will provide a more in-depth discussion about the case study results.

Project Description
In this dike project, parts from the dike need to be improved in order to ensure water safety in the future. The entire range of the dike improvements is 14.9 kilometers. For the water safety of the river area it is necessary to improve the current conditions in order to anticipate future weather conditions. On the first of January 2017, new legislation regarding the water safety has been implemented. By 2050, all the primary dams will need to satisfy these laws. This is a challenge with major impact.

The early project phase of this project started up in May 2017. The first phase will be completed by October 2017 and the entire early project phase will be finished in May 2018. Thus the total early project phase will take approximately one year.

Project Management Methodology
The respondents explained that they have applied their own methodology. The method is not specifically defined but it is described in the project management plan. The method is based on how quality will be delivered in the project. One respondent added that they didn't deliberately choose one of the ten project management methods as mentioned in the quality plan. The respondent stated that the focus of the management approach for this project is on the general thought of integral design. To design the project organization, the IPM roles apply. However, in this project another extra role was added, namely: design leader (to connect technical and environmental management). Additionally, aspects of lean management are implemented through adopting weekly stands to discuss the progress of the project planning.

Most evident results value management current practice
In total five project members were interviewed concerning this case study. The results of the questions regarding value management have been summarized into statements in the section below. All statements will also include a short explanation.

1. **Value in projects is found in the plan to complete the project aim within the time and budget, which is supported by all stakeholders.**
   The respondents agreed that the overall project aim identifies the value in the project. One must develop a plan that is supported by all stakeholders and at the same time is valuable to the company. One respondent added that it must be clear why this project must be completed in the way prescribed by the company. In this project the value of the dike reinforcement is to increase safety and ensuring the dikes are embedded into their environment.

2. **The plan of approach identifies how the value will be delivered.**
   The plan of approach is different from the PMP. It describes why the client should select the company, and is a document, which is discussed throughout the project process. Within this document what is valuable for dike development, what should be maintained and what can be improved is described.

3. **The client requirements specification guides the project team throughout the project to live up to the required expectations.**
   By ensuring the right people, who have the right/required knowledge and expertise, are involved throughout the design process is one way to make sure value is delivered. However, in order to deliver the right value, one will also need to know what that value is in the eyes of the client. Collecting the requirements in order to understand the value as viewed by the client is completed through client requirements specification (KES) elements. The respondents mentioned that they have started to develop client aim audits referred to as KES0 (products established for the aim of the project) and KES1 (summary of reactions provided during design sessions after capturing the project aims). The KES are reports that are developed at the beginning of the project and between phases to decide upon required products.

4. **Value delivery and control is measured by checking the acceptance of the client. However making it explicit is often unclear.**
   All respondents agreed that it is important to deliver value and find a way to control the value throughout the management of the project. The respondents mentioned that they want to complete projects that add value. Thereby one respondent indicated that the project team often wants to measure and monitor value but how this should be done is often unclear. Another respondent stated that checking the acceptance from the client perspective as well as the controlling body completes the control of the eventual value. Additionally, another respondent added that it is important to make value tangible.

5. **Through a good process a valuable project can be realized.**
   All respondents recognized a difference between value for projects and the value for a project process. During the process it is really important to involve all stakeholders appropriately. This is important to create support for the project. Nonetheless, in the end the project and the process will have the same goal. Moreover even though eventually a project is good, it doesn't have to mean that the process also went smoothly.

6. **The project process can make a difference to the project and is increasingly viewed to be important.**
   Nowadays project process is becoming increasingly important in the way that we should not only focus on satisfying the project contents but also focus on the satisfying the process as experienced by the stakeholders. One of the respondents explained the additional importance of the process value as the value in projects is very definite and the value of a process is the resource. The process can make a difference to the project when the process is efficient, there is good teamwork, requirements are adapted to fit expectations, and the scope questioned throughout the project.

7. **A drawback often experienced in value delivery is the management of expectations from the client.**
   The response of the interviewees was that as the project is still running, it would not be completely accurate to answer this question momentarily. Overall the respondents replied that up till now there have not been any major drawbacks. However, there are always changes that need to be made to products as requested by the client. Therefore, even if it is a minor drawback – it is a drawback often experienced in terms of value.

8. **In order to cope with the time pressure in projects better, it will be advisable to take the time to discuss the project value and deliveries accordingly.**
   Two of the respondents mentioned that in projects people are often inclined to speed up without considering if this is also what the client is expecting, would like, and consider valuable. By setting a moment to sit down with the client and discuss the project and progress, ways can be discussed to be able to deal with the time pressure but also live up to the value of the project as expected. A simple example is that often very detailed and long reports are delivered, but this can also be reduced to delivering only the essence (if the client agrees on this).

Most evident problems project management current practice

In this section the most evident problems established by the five interviewees in current practice are described. The results have been summarized into statements along with a short description beneath.

1. **Specialists often lack the skills to communicate their good work appropriately to the client.**
   Respondents stated that at the company is known to have many good specialists. The specialists are very good at doing their job however the communication with the client and being able to manage their expectations accordingly often lacks. One of the respondents added that the team shouldn't only be working by themselves, but instead also in close collaboration with the client.

2. **In case of holidays, scheduling is often too tight and not enough people are available. Changes should be made in schedules for these periods.**
   During the holidays notice should be taken of fewer employees available for projects and the planning should be arranged differently. For this project one of the respondents mentioned that part of the early project phase was during the summer period, which was very busy as a lot of people were away on holidays. Therefore a lot of extra hands were missing, which had an impact on the project process.

3. **The expectations of the deliveries are often a mismatch.**
   Often team members are provided with tasks and go off to work on these tasks for as long as this is allowed according to the planning. Not often the products are also discussed in-between, as employees often argue that specialists should be given the time to complete correct calculations. Nonetheless by letting people work by themselves, people will interpret requirements and expectations in their own way. From experience, this had often led to a mismatch of deliveries.

4. **Project team members are often not available at the same days / times.**
   Within project teams it is often difficult to find a timeslot when everyone is available. Nonetheless it extremely important, as if the meeting day is regularly on a Monday and

one of the members is never able to attend – this will disrupt the teamwork and progress of products and also causes miscommunications. Therefore the project teams should spend more time on arranging agenda's to fit each other at least once a week with the project team.

Most evident opportunities project management current practice
In this section the results of the five interviewees are displayed regarding the opportunities they identified in current practices. The results are summarized in statements followed by short explanations.

1. **Additional alignment with the client can clarify responsibilities and expectations.**
   In order to be able to change to a new management approach for a project, the client will also need to agree. Therefore, the approach should always be discussed with the client and made clear. After this is done, together with both teams the responsibilities and expectations can be set. For example, agreements should be made when the client will be involved and when specialists will need to work on their products (when it is less interesting for the client to join sessions). Furthermore one of the respondents added that changing people's attitude is very difficult, however in order to try and change people's attitude they should at least clearly be explained about the required changes in their attitude in order for them to at least understand the changes.

2. **Spending more time on correct attitudes within teams and proper collaboration.**
   Several of the respondents explained that the problems in teams are often the people and their behavior within the team. Teamwork is therefore extremely important. Whether you stick to your original planning or not, a nice collaboration in a good environment is hard to control. A way to find control over a nice collaboration is by spending more time on correcting attitudes and planning informal meetings that allow the team members to also get to know each other outside of the project. Also towards the client, complications can occur if the collaboration isn't good and the company's team isn't able to connect with the client's team. By introducing trainings and team coaches, the project teams can learn how to work together and collaborate properly.

3. **Organize more sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project.**
   By organizing sessions with the client, the project team will be able to check the requirements and ask for feedback when necessary. These sessions should not only take place at the beginning of the project but also throughout the project. This will allow the project team to complete timely changes and will likely result in less rework of products.

5.2 Cross-Case Analysis

The previous section of this chapter explained the results of each case study individually. This section shall analyze the outcomes of the different case studies altogether. Hence the differences and similarities of the case studies will be discussed for the different aspects explored during the case study interviews. Firstly the characteristics of the case studies, followed by evident results of value management, evident results value measurement criteria, evident results of the problems endured in current practices, and the opportunities found in current practices will be discussed. Finally, the outcomes will be compared to the previously performed literature review. Some of the results have been moved to Appendix C6, as they are considered less relevant for the main objective of the research.

Characteristics of the case studies
Before comparing the in-depth results of the interviews for each case study, it will be interesting to see if there are any major differences between the projects apart from the status that they are currently in (completed, half completed, or still running). The table below summarizes the duration, approximate budget, approximate team size, approximate main number of external parties, as well as the project management methodology applied.

#	Status	Type of Project	Duration (Months)	Team Size	External Parties	PMP	PM Method
1	Complete	Dike	36	30	10-15 parties	1 document, updated per phase	IPM roles, lean aspects
2	Complete	Highway	30	30	6-8 parties	3 documents, 1 per design loop	BVP, lean aspects
3	Complete	Bridge	24	40-45	20-25 parties	1 document, updated per year	IPM roles, lean aspects
4	Partly running	Dike	18	60	5 parties	1 document, updated per phase	IPM roles
5	Running	Dike	12	15-20	5 parties	1 document, updated per phase	IPM roles

Table 26: Case study characteristics for the cross-case analysis

The duration of the five case studies differ from 1 to 3 years. The projects that took up to 2,5-3 years have revealed a similar team size, namely thirty employees. However this cannot be considered a pattern as the shorter case studies taking up 1 to 1,5 years have revealed an unregularly variation in team size. The dike project that took one year had a team size of approximately 15 employees whilst the project taking up 1,5 years revealed a team size of 60. Contrary the project that took 2 years to complete again had a smaller team size, namely approximately 40 employees. Hence, the duration of the project does not seem to have an influence on the team size. Nonetheless, the fourth project with a team size of 60 will be interesting to analyze in order to see if any issues have been experienced in current practices for -larger teams.

Moreover three different types of projects were completed, namely: a dike, bridge and highway. The type of projects does not appear to reveal a similar pattern for the duration, team size or external parties. The only characteristics that all dike projects have in common is that the projects applied IPM roles and completed one PMP document at the beginning of the project and updates the PMP after each project phase.

Hence, all of the project characteristics are relatively different in comparison to each other. Thus, the cross-case analysis will provide a broad overview of evident results in current practice. By comparing the similarities between the different case studies, evident results can be derived.

Evident Results Value Management Current Practice

In this section all of the value management results will be analyzed. As mentioned in the case study set-up, every interviewee was enquired the same questions during the interviews. In total 4-5 respondents were selected for each case study. In this section the results formed for each case study regarding value management will be compared in order to form evident results for the construction industry in an early project phase.

#	Value Management	Case Study				
		1	2	3	4	5
1	Value in projects is found when the project aim is realized within the budget and time.	√			√	√
2	Value in projects is found when the project aim is realized.	√	√	√	√	√
3	Added value is created when optimal solutions are unraveled that exceed the client's expectations.	√	√			
4	During value engineering session's wishes from stakeholders can be collected and identify the value that will need to be delivered. These sessions improve interfaces. However, these sessions should be completed on a regular basis.	√	√	√	√	
5	A plan of approach identifies how the value will be delivered.					√

6	Value is implicitly controlled, but nonetheless very important in order to prevent dilemmas during later project phases.	√	√	√		
7	Making value delivery control explicit is often unclear.					√
8	Value delivery and control is important due to social responsibilities and to be able to accomplish the quality as demanded.				√	
9	In case of very complex projects where changes occur daily, we deliver value in the short-term sense by going with the flow. There is only structure for the main milestones in the long-term sense.				√	
10	The client requirement specifications guide the project teams throughout the project.					√
11	An adequate focus on project process is able to establish added value.		√			√
12	Value of projects and project processes are different, however they are interrelated.	√			√	
13	Project value is result-driven whilst project process value is related to the way you get to your result.			√		
14	There is a difference between value of processes and projects; however this is still new in our projects and vague.				√	
	Total amount of value management statements identified per case study	6	5	4	7	6

Table 27: Value management statements

A value management statement recognized in all projects was value in projects is found when the project aim is realized. A sub-team project leader, assistant core team roles, project managers, a project leader, a technical manager, and a contract manager recognized the statement. All of these project roles are part of a manager role, but in different disciplines. Therefore, it will likely be that this value definition as provided will also be identified in other projects.

The statement during value engineering session's wishes from stakeholders can be collected and identify the value that will need to be delivered, was recognized in all of the completed projects as well as the partially running project. Respondents stated that the sessions improve interfaces. However, the sessions should be completed on a regular basis. Reasoning for not recognizing the value engineering sessions in the running project could be due to the status of the project. This is also indicated in the other four projects, as respondents have remarked that the value engineering sessions were often established later on in projects. Nonetheless, respondents agreed that the sessions should be organized more on a regular basis in the future.

The statement recognized in all of the dike projects was value in projects is found when the project aim is realized within the budget and time. These dike projects have the IPM roles and type of PMP document in common. Thus this could indicate that within the project PMP documents budget and time were considered to be the most important focus in order to achieve value. The respondents that identified this value statement were two project leaders from different projects, a sub-team project leader, and a project manager. All of these respondents are from the core IPM team, making the statement important in current practice.

Value being implicitly controlled was identified by all of the completed case studies. An additional similarity for these projects is that they are of the longest length, being and all completed. Nonetheless, measuring value implicitly does not seem to have a likely 2-3 years. Hence there could be a relation with measuring value implicitly and project duration.

Added value created through optimal solutions was recognized in the completed highway and dike project, also being the projects with the longest duration and same team size. The statement was recognized by half of the respondents in the dike project lasting 3 years and one respondent in the highway project lasting 2,5 years. The respondent roles that identified the statements were: two sub-team project leaders and one assistant for the core team.

An adequate focus on project processes was identified in the two most different projects, namely the one of the longest and completed highway project with a simplified smaller PMP for each phase and the running dike project with the smallest team size and taking up the shortest amount of time. Hence regarding the project characteristics, no particular similarities can be

established. The respondents having identified this statement were an assistant of the core team for the highway project and the project leader for the dike project. As both roles were involved in the core team, but the projects were rather different a pattern in project role for added value can be established.

Moreover, a difference between value in a project and a process was recognized in two dike projects, one being the longest project of 3 years and the other project one of the shortest namely 1,5 years. For the longest dike project a specialist mentioned this statement and for the shorter dike project the project manager. Hence as the project characteristics of both projects are very different as well as the respondents mentioning the statement, the statement can be considered a general value management statement that is likely to occur.

Nonetheless some of the respondents mentioned to be unaware of the difference between project and process value. However the unawareness was recognized respondents with the least amounts of years of experience. Likely due to the great amount of responsibilities and newness of value management, the respondents were unsure of the meaning and implications of value management.

Altogether the respondents from the partially running dike project with the largest team size identified the most value management statements. Nonetheless, most of the value management statements mentioned were also recognized in other projects. Value delivery and control is important due to social responsibilities and to be able to accomplish the quality as demanded was identified by half of the respondents, namely: the project leader as well as the sub-team project leader. As the statement was mentioned by half of the respondents and these respondents also have an important management function in the project, this statement will be taken into account for the remaining analysis and results of the case studies. Only one respondent in the partially running dike project identified short-term delivery for complex projects, being the project manager. As only one respondent recognized this statement but the respondent had great responsibilities for the management of the case study, this statement will be taken into account with medium relevance.

The respondents from the longest case study of three years recognized six value management statements in total, from which all were also recognized in other case studies. The shortest duration case study also identified six value management statements; however three of the statements were only recognized in that particular case study. The project manager, project leader, and technical manager recognized a plan of approach to identify value delivery. Similar to the cost-benefit analysis for the early project phase activities, this could be a project specific value statement. However, as it was mentioned by more than half of the respondents, who were also involved in the core management of the project, the statement will be considered to occur sometimes. Moreover the second and third statement only recognized in this project regarded client specifications guiding project teams and making value control explicit. The contract manager only recognized these two statements. As the contract manager had a side role in this project and mentioned many times to be less aware of the project progress, team, deadlines, deliveries etc. Therefore, this value statement will not be taken into account as to occur often.
Lastly the completed bridge project identified one additional value statement, namely: project value is result-driven whilst project process value is related to the way you get to your result. The statement was recognized by half of the respondents, being both the project managers. Likewise, due to their project roles the value statement will be taken into account as sometimes to occur.

#	**Value Management**	**Relevance**
1	Value in projects is found when the project aim is realized.	High
2	During value engineering session's wishes from stakeholders can be collected and identify the value that will need to be delivered. These sessions improve interfaces. However, these sessions should be completed on a regular basis.	High
3	Value in projects is found when the project aim is realized within the budget and time.	High

4	Value is implicitly controlled, but nonetheless very important in order to prevent dilemmas during later project phases.	High
5	Added value is created when optimal solutions are unraveled that exceed the client's expectations.	High
6	An adequate focus on project process is able to establish added value.	High
7	Value of projects and project processes are different, however they are interrelated.	High
8	A plan of approach identifies how the value will be delivered.	Medium
9	Value delivery and control is important due to social responsibilities and to be able to accomplish the quality as demanded.	Medium
10	In case of very complex projects where changes occur daily, we deliver value in the short-term sense by going with the flow. There is only structure for the main milestones in the long-term sense.	Medium
11	Project value is result-driven whilst project process value is related to the way you get to your result.	Medium
12	Making value delivery control explicit is often unclear.	Low
13	The client requirement specifications guide the project teams throughout the project.	Low
14	There is a difference between value of processes and projects; however this is still new in our projects and vague.	Low

Table 28: Overview occurrence value management current practice

Hence the table illustrates the relevance of each of the value statements as previously described. In total the table identifies seven value statements that are very likely to be highly relevant in different projects in current practice. Another four value management statements are likely to sometimes occur. Moreover the last three value management statements are not likely to occur in different projects. The statements are mainly related to a particular project in which they were established or due to the respondent that identified it. As explained, the low relevance was established due to lack of recognition or function of the respondent that recognized the statement.

Next to value management statements, opportunities for value delivery were also discussed with all of the respondents. For the opportunities, all of the projects considered different opportunities. Thus making it difficult to establish whether the opportunities for value delivery are project related or for general value delivery. Altogether like the recognition of the value management statements, the partially running dike project also recognized the most (2) opportunities for value delivery.

#	**Opportunities in value delivery**	**Case Study**				
		1	**2**	**3**	**4**	**5**
1	Focusing more on the management of project processes in terms of teamwork and communication. This will increase value.	√				
2	Opportunities for optimal value delivery are found in improved methods of communication.		√			
3	Opportunities in value delivery are found in making people more aware of lost and added value in projects.			√		
4	An opportunity for increased value delivery could be to organize sessions together with specialists and the client and managers directed to discuss either team problems, communicative problems or content questions.				√	
5	Opportunities in value delivery are found by spending more time and sessions on the interfaces between important products.				√	
6	In order to cope with the time pressure in projects better, it will be advisable to take the time to discuss the project value and deliveries accordingly.					√
	Total amount of value opportunities identified per case study	1	1	1	2	1

Table 29: Opportunities in value delivery

The partially completed dike project recognized organizing more sessions between clients and specialists. The project manager recognized the opportunity. Hence as an important role recognized this opportunity but it was only recognized once, the opportunity will be considered to be sometimes relevant. The other opportunity recognized in this project was spending more time on interfaces between projects. This opportunity was recognized by three out of the four respondents (two sub-team project leaders and the project leader). Therefore this opportunity will be considered to be highly applicable.

In the longest completed dike project focusing more on management of processes increases value was identified by only one of the four respondents. The respondent was a sub-team project leader. As the opportunity was only mentioned once, the project role mentioning the opportunity was outside of the core team, and the respondent had one of the least amounts of years of experience, the opportunity will be considered to be of low relevance.

For the second longest project being a highway, an opportunity was considered in improved methods of communication. The opportunity was identified by three out of the five respondents (sub-team project leader, assistant core team and project manager) and will therefore be considered highly relevant.

Next, in the bridge project an opportunity was established in making people more aware of added and lost values in a project. This opportunity was only mentioned by one of the respondents being the project manager. As only one respondent mentioned the opportunity, but the respondent had a role highly involved in the project management, the opportunity will be considered to have a relative relevance.

Lastly, the shortest project recognized an opportunity in taking more time to discuss project values and deliveries. The opportunity was recognized by three out of the five respondents. Hence this opportunity will be considered to be highly relevant.

As all of the value delivery opportunities have only been mentioned in one case study, only the value opportunities that are considered to have a high occurrence will be taken into account in further analysis of the cases. The other three opportunities are more related to a specific project or respondent who identified the opportunity.

#	**Opportunities in value delivery**	**Relevance**
1	Opportunities for optimal value delivery are found in improved methods of communication.	High
2	Opportunities in value delivery are found by spending more time and sessions on the interfaces between important products.	High
3	In order to cope with the time pressure in projects better, it will be advisable to take the time to discuss the project value and deliveries accordingly.	High
4	Opportunities for optimal value delivery are found in improved methods of communication.	Medium
5	An opportunity for increased value delivery could be to organize sessions together with specialists and the client and managers directed to discuss either team problems, communicative problems or content questions.	Medium
6	Focusing more on the management of project processes in terms of teamwork and communication. This will increase value.	Low

Table 30: Overview opportunities value delivery current practice

Similar to the opportunities identified for value delivery, drawbacks in value delivery were also different per case study. As each case study was able to identify different drawbacks, it will be difficult to distinguish an overall drawback in current value delivery.

#	**Drawbacks in value delivery**	**Case Study**				
		1	**2**	**3**	**4**	**5**
1	Not all employees are trained and know how to apply particular project management methodologies as suggested during the project.	√				
2	A drawback in value delivery is found in the fear of negative judgement.			√		

3	Drawbacks in value delivery are found in client relations and lack of proactive interference in decisions made by the client.		√			
4	A drawback often experienced in value delivery is the management of expectations from the client.					√
5	Drawbacks in delivering value are found in the high time pressure, which makes it difficult to deliver adequate quality of products.				√	
6	It is difficult to determine how to achieve maximum value in projects as work is often completed parallel to each other due to time pressures.	√				
	Total amount of value drawbacks identified per case study	2	1	1	1	1

Table 31: Drawbacks in value delivery

Overall, the respondents from the longest time duration project derived the most value drawbacks in their project. The interviewees identified two drawbacks. The drawback regarding lack of training of employees was recognized by half of the respondents, namely: the sub team project leader and discipline project leader. As half of the respondents mentioned this drawback, it will be considered likely to occur. Moreover the second drawback recognized in the longest project regarded difficulties in determining maximum value. As the drawback was only mentioned by one of the respondents it will be considered less likely to occur.

The respondents from the completed highway project recognized a drawback regarding client relations and lack of proactive interference, which was recognized by half of the respondents – the project manager and assistant technical manager. Likewise, as half of the respondents recognized this drawback, the drawback will be considered likely to occur.

The respondents from the completed bridge project also recognized one drawback regarding fear of negative judgement in deliveries. The project manager identified the drawback. Likewise, due to the project role having identified the drawback, the issue is considered relatively likely to occur.

For the partially running dike project all respondents identified the drawback in high time pressures making it difficult to deliver adequate quality of products. Therefore as all respondents recognized the drawback, the relevance of the drawback will be considered highly.

Lastly, the shortest duration case study identified a drawback in managing expectations of the client, which was identified by three out of the five respondents. The respondents who identified the problem were the project leader, technical manager and the contract manager. Therefore, due to the project roles and that more than half of the respondents in the case study identified the drawback, the issue is considered of high relevance.
The table below summarizes all of the drawbacks experienced in the different case studies, and their relevance. The relevance was based on the amount of times the drawbacks were mentioned as well as which project roles mentioned the drawbacks.

#	**Drawbacks in value delivery**	**Relevance**
1	Drawbacks in delivering value are found in the high time pressure, which makes it difficult to deliver adequate quality of products.	High
2	A drawback often experienced in value delivery is the management of expectations from the client.	High
3	Not all employees are trained and know how to apply particular project management methodologies as suggested during the project.	High
4	Drawbacks in value delivery are found in client relations and lack of proactive interference in decisions made by the client.	High
5	A drawback in value delivery is found in the fear of negative judgement.	Medium
6	It is difficult to determine how to achieve maximum value in projects as work is often completed parallel to each other due to time pressures.	Low

Table 32: Overview drawbacks in value delivery current practice

As all of the six value drawbacks have only been mentioned in one case study, only the value drawbacks that are considered to have a high occurrence will be taken into account in further

analysis of the cases. The other two drawbacks are more related to the specific project or respondent who identified the drawback.

During the interviews the value measurements criteria as found in the literature review were provided. Each interviewee was asked to identify the performance for all criteria. Furthermore the interviewees were asked if they measured the proposed criteria. Moreover if they measured the criteria, they were asked to elaborate on this, and explain how they measured the criteria. The table below illustrates the measured criteria per case study, as well as the criteria that the respondents would have like to measure in each case study (WL).

Value Management Criteria	**Case Study**				
	1	**2**	**3**	**4**	**5**
Project Criteria					
Cost of a project	√	√	√	√	√
Timescale	-	√	-	√	√
Scope	√	√		√	-
Quality	√	√	√	√	√
Client + Stakeholder Satisfaction	-	√	√	√	√
Process Criteria					
Scheduling	√	√	√	√	√
Interim Client + Stakeholder Satisfaction	√	√	WL	WL	√
Teamwork	WL	√	-	WL	
Budgeting	√	√	√	√	√
Performance Information	√	√	-	√	-
Resources	-	-	-	-	-
Scope	√	√	√	√	-
Communication	√	-	-	√	-
Risks	√	√	WL	√	√
Quality	√	√	-		√
Individual Mentality	√	-	WL	-	-
Managing changes	-	√	-	-	√

Table 33: Value management criteria cross-case analysis

As the table shows, two criteria to measure project value were measured in all case studies, namely cost of a project and quality. None of the other criteria were coherently recognized as something the respondents would like to measure. For the project process, two criteria (scheduling and budgeting) were coherently recognized to be measured in all case studies and another two of the criteria (interim client + stakeholder satisfaction and risks) were concluded after revising the individual interviews and considering what the respondents would like to measure in the future. As the table shows, two completed and the running project are already measuring interim client satisfaction and other respondents in the remaining two projects would like to measure this. Additionally only the completed highway project with three sub PMP's measured teamwork. However, respondents from the longest duration dike project and partially running dike project have mentioned to want to measure this criteria. This likely indicates that a lot of the interviewees are increasingly finding interim client + customer satisfaction and teamwork important in project processes.

An interesting observation is found for the completed highway project, as this project has shown to measure the most value criterion. As the project is also the only project with sub PMP's, this could indicate that the reasoning for sub-PMP's is possibly due to value in projects and processes. For this project, all respondents mentioned not to want to add any other criterion next to the value measurements criterion of projects and project processes of early project phases than already stated.

For the longest duration case study, teamwork was mentioned as a criterion that the respondents would like to measure. One of the respondents mentioned to already measure this in their interview. The respondent mentioned to have hired a team coach that trained and team on basic communication skills and teamwork both during entire project meetings and for sub-teams.

Strikingly none of the other four respondents mentioned to have worked with a team coach, which was why the criterion was left out initially. Two of the respondents mentioned to have liked to be able to measure the project teams and teamwork. Therefore in total three out of the four respondents mentioned to find teamwork an important criterion that should be measured in the project process.

Moreover for the completed bridge project respondents mentioned many criteria that they would like to measure as they alleged that measuring more could make a difference to the project. Measuring interim client + stakeholder satisfaction was mentioned by both project managers and risks were mentioned by the advisor on value engineering as well as one of the project managers. Individual mentality was only recognized by one of the respondents, but seeing as the respondent is the advisor on value engineering – this criterion was considered to be important for the value of the project process.
A noticeable result in this bridge project was gathered from the results of the project managers. One of the managers mentioned not to measure anything in the project or project process and the other project manager mentioned not to be aware of how to measure most of the project process criteria. Thereby implying that there is a lack of training in value measurements.

The four respondents interviewed for the partially running dike project mentioned to want to measure interim client + stakeholder satisfaction, teamwork, as well as process quality. The project leader, project manager, as well as the cluster manager (project leader sub-team) mentioned to want to measure interim client + customer satisfaction. As three out of the four respondents (with an important management role) mentioned to find this criterion as something they would like to measure, the researcher will analyze the resemblance with current practice problems and opportunities in the next section. Furthermore one of the cluster leaders and the project management mentioned to want to measure the teamwork, in particular the quality of the people involved in the teams.

For the shortest time duration dike case study, four out of the five respondents mentioned not to want to measure any additional criteria. Two of the respondents mentioned that this was due to the project still running and having started up in May 2017. The respondents mentioned that measuring criteria was not yet necessary in this phase. Another respondent mentioned that there is a lack of available methods to be able to measure more. Also another respondent mentioned that the project team is mostly accountable for the product and less for the process. This explanation (provided by the design project leader of the project) appears not to match the other interviewees of the core team. Lastly, one of the respondents mentioned to want to measure teamwork in the project process. However, since the respondent was the only one to mention this and their project role is less involved with other disciplines the criterion was not taken into account in the table above.

Evident Results Current Practice Project Management Problems
During the case study interviews, all respondents were asked to explain problems encountered in current practice project management. In the first section of this chapter, the problems for the different respondents for each case study will be explained. The table below provides an overview of all of the problems in all case studies.

Problems in Current Project Management	**Case Study**				
	1	**2**	**3**	**4**	**5**
Difficulties in finding the right people for the project who are able to cope with project uncertainties and changes, and who also fit well in the project team.	√		√	√	
The client is often more than one person. When products are audited, this often results in different opinions (feedback) on the work delivered.	√				
Often not enough time is spent together with the team at the same location. Team members often choose to work at their own offices.	√		√	√	
Last-minute changes are often requested, which result in a field of tension between time and quality of deliverables.	√				
Often the project team is not provided with proper documents (current, reliable, or complete), influencing the quality of deliverables.	√		√		

Different languages used within projects often cause miscommunications/interpretations and confusions.	√	√			
People can be advised to change and follow a new methodology; however it is in their nature to go back to methods in which they feel comfortable once they are no longer checked up on.		√			
Communicating updates properly and to the right people.		√			
Tracing documentation of products is often an issue. Files are often located in different folders. Lack of structured information management.			√		
Most of the organizational culture is still quite traditional and conservative, making it difficult to change.			√		
Often the question behind the question is not answered, leading to frequent reworks.				√	
Within the team, members often share a different scope vision due to lack of scope monitoring.				√	
Sometimes we cannot influence the client's involvement if the client does not have the time to join team sessions.				√	
Schedules are often tight, which makes it almost impossible to follow it accordingly if changes occur.				√	
Specialists often lack skills to communicate their good work appropriately to the client.					√
In case of holidays, scheduling is often too tight and not enough people are available. Changes should be made in the schedules for these periods.					√
The expectations of deliverables are often a mismatch.					√
Project team members are often not available at the same days/times.					√
Total amount of problems identified per case study	6	3	5	6	4

Table 34: Evident problems current practice project management

In total for all of the five case studies and twenty-two respondents, eighteen problems were established. However, only four problems were also identified in other case studies. All other fourteen problem statements were only identified once in the different case studies. However, some of these problems can still be important in current practices and will therefore still be discussed.

Firstly the case studies that have encountered the most problems will be enlightened. According to the respondents results the longest duration dike project and the partially running dike project have encountered the most problems.

The longest duration dike project has encountered six problems, from which four of these problems have also been recognized in other case studies. The first problem being that the client is often more than one person. Hence this can lead to different feedback as everyone has their own judgement on the products delivered. Sometimes this feedback can be contradictory which makes it harder for the project team to clearly understand what the client is expecting. Only one of the respondents (project leader) mentioned this problem in the interview. Nonetheless, the completed highway project and the running dike project mentioned to work with a counter team as a client – meaning that they are also confronted with more than one client. Therefore it is imaginable that this problem has occurred more frequently, and is important to take into account.
The second project management problem, being: last-minute changes are often requested, which result in a field of tension between time and quality of deliverables. One respondent also only mentioned this problem. As the respondent was a specialist, and is less involved in the project management discipline, this problem is considered less important. The problem is likely also related to the communication problems mentioned later on in the list.
Moreover, remaining two problems were the most commonly identified problems mentioned in the longest duration project, the completed highway project and the partially running project. The first most commonly recognized problem was difficulties in finding the right people for the project who are able to cope with project uncertainties and changes, and who also fit well in the

project team. The project characteristics such as size, duration, external parties and status in which the problem was mentioned do not have a similar pattern between case studies. Therefore, the problem seems to be related to all types of projects. The longest duration case study also mentioned this problem to be a drawback in value and that the respondents would like to measure teamwork in the future. Likewise, the respondents from the partially complete project also mentioned to want to measure teamwork, and in specific the people involved in the teams.
Another problem commonly identified was: 'often not enough time is spent together with the team at the same location. Team members often work at their own offices.' Likewise this problem is also related to teamwork and individual mentality to a certain extent. Thus this problem appears to be a general problem encountered in different types of projects.

Next, respondents from the partially running dike project mentioned two problems that are also encountered in other case studies. An additional four problems were only identified in this particular case study. The first problem being that often the question behind the question is not answered, leading to frequent reworks. The project manager only identified this problem.
The same manager in the partially running project stated that there was a lack of vision on the scope. As these two problems were identified by a single respondent who was also from a different company, the essence of the two problems could be related to company culture.

The problem regarding the influence on client's involvement was only mentioned by the project leader. As the project leader has an important role in the project management, this problem will be taken into consideration with medium relevance. The next problem only mentioned in this particular project regarded the influence of tight scheduling on change management. The problem was identified by three out of the four respondents (project leader, project manager, and cluster leader) and is therefore considered as a problem that was likely experienced by more people in the project team, and possibly also in other projects.

Moreover, other problems identified in more than one project were the two of the problems regarding information management. The longest duration and completed bridge project recognized that often project teams are not provided with proper documentation. This problem is not within the influences of the project team, making it difficult to overcome as the origin of the problem is less clear (why the documentation is not provided or incomplete). The respondents that recognized this problem were all engaged in different project roles, namely: project leader, specialist, and value engineering consultant. Hence as many different disciplines recognized this problem, the problem will be considered important in project management.

Another problem identified in the longest duration and completed highway project was that miscommunication/interpretations are often caused due to different languages used within projects. For the longest duration the project leader for the hydraulic engineering discipline identified the problem, and for the completed highway project the project manager. Notable in regards to project characteristics for this problem is that both projects consisted of the same team size. Nevertheless it seems unlikely that this problem is related to a team size of thirty.

For the completed bridge case study, three out of the five problems were also recognized in other case studies. The other two others regarding tracing documents and the traditional organizational culture were only recognized in the third case study. Both these problems were recognized by the same person, the project manager, who did not measure any value criteria in projects and project processes. As the issues were both only mentioned once and by the same respondent, the likeliness of the occurrence of the problem is less likely compared to the other problems identified in the case study.

For the running dike case study, none of the four problems were also identified in other case studies. Hence this could either be problems related to the way the project started or they are project specific. The first problem regarding the lack of communicative skills was identified by the project leader, the second regarding holidays and different schedules by the technical manager, and the last two regarding expectations and availability of team members by the contract manager. As the contract manager mentioned to have a side role in the project, and the respondents identified problems were only mentioned by the contract manager – they are considered to occur less likely. The first two problems were also both identified by one manager,

however both project roles were closely involved in the core team and highly involved in the different project disciplines – these problems are considered of medium occurrence.

Conclusively, the table below will summarize the relevance of all of the problems encountered in current practice project management.

#	Problem	Relevance
1	Difficulties in finding the right people for the project who are able to cope with project uncertainties and changes, and who also fit well in the project team.	High
2	Often not enough time is spent together with the team at the same location. Team members often choose to work at their own offices.	High
3	Often the project team is not provided with proper documents (current, reliable, or complete), influencing the quality of deliverables.	High
4	Different languages used within projects often cause miscommunications/interpretations and confusions.	High
5	Schedules are often tight, which makes it almost impossible to follow it accordingly if changes occur.	Medium
6	The client is often more than one person. When products are audited, this often results in different opinions (feedback) on the work delivered.	Medium
7	Sometimes we cannot influence the client's involvement if the client does not have the time to join team sessions.	Medium
8	Specialists often lack skills to communicate their good work appropriately to the client.	Medium
9	In case of holidays, scheduling is often too tight and not enough people are available. Changes should be made in the schedules for these periods.	Medium
10	Last-minute changes are often requested, which result in a field of tension between time and quality of deliverables.	Low
11	People can be advised to change and follow a new methodology; however it is in their nature to go back to methods in which they feel comfortable once they are no longer checked up on.	Low
12	Communicating updates properly and to the right people.	Low
13	Tracing documentation of products is often an issue. Files are often located in different folders. Lack of structured information management.	Low
14	Most of the organizational culture is still quite traditional and conservative, making it difficult to change.	Low
15	Often the question behind the question is not answered, leading to frequent reworks.	Low
16	Within the team, members often share a different scope vision due to lack of scope monitoring.	Low
17	The expectations of deliverables are often a mismatch.	Low
18	Project team members are often not available at the same days/times.	Low

Table 35: Overview ranking evident problems current practice project management

As already mentioned the first four problems identified in the table above, are considered to be problems that can occur in different kinds of projects. The problems 5-9 were all only mentioned in one case study, however the fifth problem was mentioned by three out of the four respondents in that case study. All of the other problems with medium occurrence were only mentioned by one respondent in one case study. Nonetheless, the project role of the respondent was considered of significance importance, which is why the problem has been considered as a problem with medium occurrence. The problems with low occurrence are likely less frequently experienced in projects, and could be related only to that particular case study.

Evident Results Current Practice Project Management Opportunities.
After having identified several problems in current practice project management, the respondents were also asked on their view of opportunities. Likewise, this section has brought the individual case study results together. The results are displayed in the table below.

In total fourteen different opportunity statements can be formulated from the five case studies and twenty-two respondents. Only hiring a team coach was mentioned as one of the opportunities was mentioned in the longest duration, partially running, and running projects. Regarding their project characteristics, all three projects are dike projects. Nonetheless, their team sizes, amount of external parties, status and duration are all very different. Therefore it will be likely that this opportunity will also be applicable to other projects and not only dike specific.

#	**Opportunities**	**Case Study**				
		1	**2**	**3**	**4**	**5**
1	Encourage people to identify a project day for each specialist discipline (next to establishing a project room).	√				
2	Make sure enough time is dedicated to getting to know each other in the project team, by for example organizing proper project startups, follow ups, as well as informal meetings.	√	√			
3	In addition to sending or discussing sub-products to the client, it will also be good to receive internal interim feedback.	√				
4	Hire a team coach who focuses on training employees in more coherent communication, teamwork and the correct attitudes within teams in projects.	√			√	√
5	Spend more time on continuously organizing sessions to update all team members.		√		√	
6	Establish periodic audits also at team level.		√			
7	Make people aware of their responsibilities also for the bigger picture.		√			
8	Encourage employees to take initiative.		√			
9	Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project.			√		
10	Provide incentives for innovative project approaches.			√		
11	Find the appropriate team of people who are willing to work with the unknown.			√		
12	Take more time to determine the project requirements and expectations together.				√	
13	Additional alignment with the client can clarify out responsibilities and expectations.					√
14	Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project.					√
	Total amount of opportunities identified per case study	4	5	3	3	3

Table 36: Overview ranking evident opportunities current practice project management

The opportunity of making sure enough time is dedicated to getting to know each other was recognized by respondents from the longest duration case studies. Reasoning for identification could be due to the experience of miscommunications in longer projects.

Spending more time on continuously organizing sessions to update the team was recognized in the completed highway and partially running dike project. Regarding the project characteristics, none seem to be similar. Thereby indicating that the type of project does not influence this opportunity, making the statement highly relevant.

The case studies that identified most of the opportunities in project management were the two projects with the longest duration. The longest duration project mentioned four opportunities, from which two have already been mentioned above. The other two opportunities were only mentioned in this case study.
Encouraging people to identify a project day and encouraging internal interim feedback were both only mentioned by one of the four respondents, and the sub-team project leader. Therefore

these opportunities will be considered as less relevant to the current problems in project management.
The completed highway project identified a total of five opportunities, from which three were only mentioned in this project. Establishing period audits also at team level was recognized by the project leader, core team assistant and project management. Therefore as the opportunity was mentioned by more than half of the respondents and also relevant management project roles, the opportunity was considered to be relevant.
Making people more aware of their responsibilities also for the bigger picture was only recognized by two out of the five respondents. Nonetheless, due to their project roles in the core team, this statement will also be considered relevant. Lastly the statement regarding encouraging employees to take initiative was recognized by the sub-team project leader as well as the core team assistant. Hence less than half of the respondents have indicated this opportunity. As these respondents' roles are less involved in the management of all of the different disciplines, the opportunity is considered to be less relevant.

For the completed bridge project, all opportunities were only mentioned in that particular case study. Establishing shorter design cycles and sub-deliveries was recognized by half of the respondents, both the project managers. Therefore the statement will be taken into consideration as relevant. The last two statements regarding finding appropriate team members and providing incentives for innovative approaches were identified only once and by the same project manager. Therefore, they will be considered to be less relevant.

Next the partially running dike case study also identified three opportunities. Two of these, have already been mentioned and are also identified in other case studies. The other opportunity regarding taking more time to determine requirements and expectations together was recognized by the project leader, project manager as well as the sub-team project leader and was thereby identified by three out of the four respondents. Therefore the opportunity is considered to be relevant.

Lastly, for the running dike case study another three opportunities were identified. One of these opportunities has already been mentioned. The other two were only mentioned in this case study. Additional alignment with the client to clarify responsibilities and expectations was recognized by two out of the five respondents, which is less than half. Seeing as one of the respondents was the sub-team project leader and the other the technical manager, the opportunity was considered to be less relevant. The last opportunity regarding regularly organizing sessions with the clients was mentioned by the project leader as well as the technical manager. As this statement was also only identified by two respondents but one of them was the project leader, the opportunity is taken into account to be relevant.

In total all opportunities have been summarized in the table below. The most relevant opportunities have been recognized in more than one case study and the medium relevant opportunities have only been recognized in one case study, however important project roles or more than half of the respondents have mentioned the opportunity.

#	**Opportunities**	**Relevance**
1	Hire a team coach who focuses on training employees in more coherent communication, teamwork and the correct attitudes within teams in projects.	High
2	Make sure enough time is dedicated to getting to know each other in the project team, by for example organizing proper project startups, follow ups, as well as informal meetings.	High
3	Spend more time on continuously organizing sessions to update all team members.	High
4	Establish periodic audits also at team level.	Medium
5	Make people aware of their responsibilities also for the bigger picture.	Medium
6	Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project.	Medium
7	Take more time to determine the project requirements and expectations together.	Medium

8	Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project.	Medium
9	Encourage people to identify a project day for each specialist discipline (next to establishing a project room).	Low
10	In addition to sending or discussing sub-products to the client, it will also be good to receive internal interim feedback.	Low
11	Encourage employees to take initiative.	Low
12	Provide incentives for innovative project approaches.	Low
13	Find the appropriate team of people who are willing to work with the unknown.	Low
14	Additional alignment with the client can clarify out responsibilities and expectations.	Low

Table 37: Overview ranking opportunities current practice project management

As some of the opportunities mentioned only in one case study are considered to be of relative relevance, all statements one till eight will be taken into consideration as relevant project management opportunities in current practice.

Conclusion

In total five case studies were first individually discussed and afterwards compared in the cross-case analysis. In order to conclude the case study results an overview of the value measurement criteria established in the case studies compared to findings from the literature review will be provided, followed by a comparative overview of the problems infrastructure projects are often faced with, a comparative overview of opportunities, and lastly a comparative overview between current practice and literature review on conventional and agile project management.

The first part of the case study interviews was dedicated to value management. In-depth information about the measures and discussions can be found in the appendix (Appendix C1-C5). In the cross-case analysis the strongest value management statements, drawbacks and opportunities in value delivery were provided. Moreover, these statements were revealed due to particular value measures applied in projects and processes. Thus the conclusion of this chapter will summarize a comparison of the value measures as provided in literature and what is current measured in practice. Hence from the exploratory interviews the researcher was able to reveal that the interviewees were in need of more information on what criteria could be measured and how. The outcomes of the exploratory interviews revealed that for projects and processes costs, organization, time, information and quality were measured either implicitly or explicitly. Moreover, generally only the project was measured. After having revised the interview protocol and provided the interviewees with options to choose from, costs and quality remained to be measured just as in the exploratory interviews. Notable is that for process the interviewees explained to measure scheduling, interim client and stakeholder satisfaction, budgeting and risks. As organization is not one of the criterion as established for value management, one would expect the interviewees to mention this criterion when they were asked if they measure any other criterion. As none of the respondents mentioned this criterion, the researcher can conclude that this criterion is not used in current practice to measure value. Furthermore, the criteria interim client and stakeholder satisfaction and risks were not mentioned during the exploratory interviews.

	Literature	**Current Practice**
Project Value Measurement Criteria	Cost of a project	Cost of a project
	Timescale	-
	Scope	-
	Quality	Quality
	Client + Stakeholder Satisfaction	-
Project Process Value Measurement Criteria	Scheduling	Scheduling
	Interim Client + Stakeholder Satisfaction	Interim Client + Stakeholder Satisfaction
	Teamwork	-

	Budgeting	Budgeting
	Performance Information	-
	Resources	-
	Scope	-
	Communication	-
	Risks	Risks
	Quality	-
	Individual Mentality	-
	Managing changes	-

Table 38: Overview literature and current practice value measurement criteria

As the table illustrates, less than half of the criteria for both projects and project processes is measured in current practice. Nonetheless, most of the respondents filled in that all criteria were performed as expected/ neutral in the project. Interestingly, scope is not measured in most case studies. Instead it is often something that is brought up to discussion during meetings, and hence implicitly measured. Additionally in the section regarding problems in current project management, many of the respondents mentioned that the teamwork (working off-site and thus being less aware of each other's progress) is often a problem and that not enough time is spent on determining the requirements together. Thereby implying that the scope is often not clear to all project members. Also, communication is often seen as a problem in projects, as many different languages are used and working off-site can lead to misinterpretations of expectations. Altogether, most of the problems encountered in current project management are established throughout the project, indicating more structure and/or measurements should be completed in the project process.

In the next section of the case study interviews, respondents were asked to identify the problems encountered in current project management. In the cross-case analysis these problems were ranked for relevance according to the amount times and case studies identified the problem as well as whom identified the problem. In order to link to results to the literature review completed at the beginning of this research, the table below will compare the outcomes gathered in the literature review with the results from the five case studies. By doing so, the research will be provided with a more complete overview of the problems recognized in current project management.

Literature Study Infrastructure PM Problems	**Current Practice Case Study PM Problems**
Complex interfaces. Project scope will often change significantly over time. After the goal is defined, it will likely change in the project. Team members often complete work with little regard for how it might affect others.	Difficulties in finding the right people for the project who are able to cope with project uncertainties and changes, and who also fit well in the project team.
-	Often not enough time is spent together with the team at the same location. Team members often choose to work at their own offices.
-	Often the project team is not provided with proper documents (current, reliable, or complete), influencing the quality of deliverables.
Difficulties in communication (interpretations, miscommunications).	Different languages used within projects often cause miscommunications/interpretations and confusions.
Activities are often interdependent (affect each other). Decision-making is often a multi-actor process. Unplanned events are unaccounted for, leaving budget contingencies sorely inadequate.	Schedules are often tight, which makes it almost impossible to follow it accordingly if changes occur.
Conflicting interests.	The client is often more than one person. When products are audited, this often results in different opinions (feedback) on the work delivered.
-	Sometimes we cannot influence the client's involvement

	if the client does not have the time to join team sessions.
Projects often lack good communication with stakeholders outside of the project team.	Specialists often lack skills to communicate their good work appropriately to the client.
-	In case of holidays, scheduling is often too tight and not enough people are available. Changes should be made in the schedules for these periods.
Risky and long planning horizons.	-
Misinformation about costs, benefits and risks due to changes.	-
Cost overruns and/or benefit shortfalls for the majority of projects.	-
Uncertainties as to scope and methods are high, due to changes.	-

Table 39: Overview literature and current practice problems project management

Roughly four out of the nine problems identified in current practice were also mentioned in the literature study. Moreover, the literature aspects that were not mentioned in the current practice results focused more on the complexity, communication, costs and high amount of changes. Contrary the results from the case studies focused more on the project teams, location of team members, information management, schedules and the clients.
Nevertheless, the problems encountered only in literature were problems that have also been discussed to some extent in the project context or discussions for the search for a more flexible project management approach for particular projects. Hence the literature review and outcomes of current practice show reasonable similarities.

In addition to the problems in project management, the interviewees were also asked to acknowledge opportunities for current project management. These results have been discussed in the previous section as well as ranked according to relevance. In order to conclude whether the opportunities in current practice can be anticipated through agile project management, the table below compares the agile characteristics concluded in the literature study with the results from current practice.

Literature Study APM Characteristics	**Current Practice Case Study PM Opportunities**
People-oriented, Cross-functional teams	Hire a team coach who focuses on training employees in more coherent communication, teamwork and the correct attitudes within teams in projects.
People-oriented	Make sure enough time is dedicated to getting to know each other in the project team, by for example organizing proper project startups, follow ups, as well as informal meetings.
Frequent face to face, collaborative development, Incremental approach	Spend more time on continuously organizing sessions to update all team members.
Retrospectives, feedbacks sessions and reviewing to continuously improve	Establish periodic audits also at team level.
Self-management of teams,	Make people aware of their responsibilities also for the bigger picture.
Sprint planning (small releases), Evolutionary development, Iterations, Frequent deliveries in short iterations, Simplicity in designs	Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project.
Re-prioritizing requirements and activities	Take more time to determine the project requirements and expectations together.
High customer involvement on-site, Adaptable projects (change management)	Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project.
Minimizing documentation	-

Table 40: Overview literature and current practice opportunities project management

As the table shows, all of the agile characteristics are able to provide for the opportunities that were presented in the different case studies. Hence the researcher can conclude that potentially agile project management characteristics can be applied to all of the recognized opportunities in a particular manner. Nonetheless, minimizing documentation is not applied to a particular opportunity.

In addition to the opportunities, the agile project management methodology was also discussed. The discussions were based on the survey results from each respondent as well as their experience with the methodology. At the beginning of this research the question was raised to what extent current practice is already applying aspects of agile project management, as well as which aspects they would like to implement in future projects. In the literature study a comparison was made between conventional project management and agile project management according to several themes were established in scientific articles. In order to evaluate the extent to which agile characteristics are already implemented in current practice, the comparison of conventional and agile project management will be discussed based on the case study results. Nonetheless the actual extent to which the agile elements, as established after the literature review, are being applied will be discussed based on the survey results.

Literature Study	**Case Study Results**		
Elements Differences PM	**Conventional Project Management**	**Agile Project Management**	**Description Case Studies**
Team Composition	√	√	Increasingly smaller teams are being implemented. However, decisions are made by specific roles and not team based. Additionally, the teams are not co-located.
Process	√	√	Only one of the case studies considered splitting the project up into three smaller projects. The other projects predefined the project aim and worked towards it.
Requirements	√		Mostly the client is only involved to verify in later stages of the project. However, increasingly team members are interested to involve the client more regularly.
Costs	√		Product deliverable lists are established which form the basis for payment net to the amount of hours spent on the deliverables. High rework costs are often endured.
Scope	√		Well-defined at the start, but often due to changes in the project process the scope will also change.
Schedule	√	√	Schedules are estimated for the long term of a project but fixed for the short term. In general, less detail is provided for a realistic short term planning. Increasingly weekly stands are being adopted, however often sporadically.
Management coordination	√		The core team decides upon important decisions for the sub-teams. Additionally, only the core team is involved with the client.
Client relations	√		The client is rarely on-site, mostly only sporadically towards the end of projects. However, through experience employees are starting to become interested in involving the client more often.
Location	√		Project teams tend to work off-site. Project rooms are often insufficient to host the project team.
Project Development	√		Each project phase is approximately 6 months. Deliveries occur at the end of phases.

Life Cycle	√		Meetings are completed at the start of a phase to identify requirements. After this, project team members are focused on their own products until the next milestone.
Skills	√	√	Mostly members with specialized skills are engaged in the project teams. Sometimes, some of the members have shown interest in multidisciplinary skills and have positioned themselves in different project roles.
Documentation	√		Often still long and detailed PMP's are written upfront for the entire duration of the project.
Reviews	√		Progress reports (milestone) are established, however they are mostly written whilst the team is already working on the next project phase.
Communication	√		Team sessions are generally organized in a formal manner at the start of the project and a follow up meeting every 6 months to one year. As project teams often work off-site, face-to-face communication often lacks.
Team member contribution	√		Specialists prefer to be left alone in order for them to be able to complete their job. Thereby an overview of the actual work becomes chaotic and information is often a mismatch in documents as the communications between team members isn't regular. Team members are often not regularly updated about progress in the project.

Table 41: Comparing conventional- and agile project management & case study results

As the table indicates, most of the current practice is comparable to conventional project management. In several cases, aspects of agile project management are implemented or starting to be implemented. For example team composition; projects are more often organizing the project into many small teams in order to improve the communication lines within the team. Also, one of the case studies has already implemented change in the project process as a PMP was made for each new project phase. The schedule is estimated for the long run of the project; however, the project phases are a set amount of time. Also teams have started to implement weekly stands in order to discuss the progress of the project. However the more conventional side of scheduling is that the focus in projects tends to be on the long term planning instead of detailed short term realistic planning. Moreover, team member skills are often specialized, however occasionally members have engaged in a more multidisciplinary role.

During the interviews, the respondents showed an interest towards the project requirements and the relation with the clients. Several respondents recognized that the clients were currently not involved often enough to verify requirements and evaluate in-between.

In conclusion regarding the five case study results that portray current practice, a lot of the agile elements are not yet implemented in the construction industry. Nonetheless, as the opportunities have shown, certain agile aspects have raised the interest of project members. Moreover, the case study results have also shown that for particular projects, some agile aspects are already implemented to some extent. However, the respondents have stated to be unaware of agile – indicating that they have implemented some aspects intuitively.

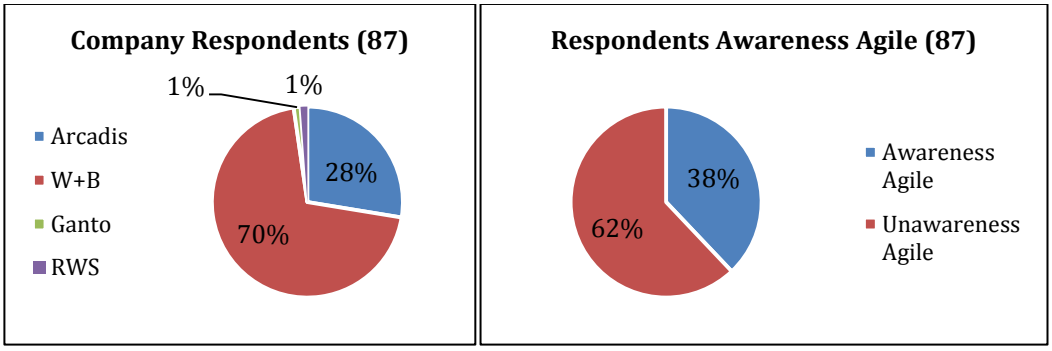
5.3 Survey Results

Next to the case studies interviews, a survey was established in order to analyze the use of agile elements in current practice. Additionally, the survey allowed the respondents to determine which values were specifically measured in their projects and processes as well as how the project was performing for each project and project process value criteria. By collecting many responses the researcher was able to develop a global understanding of the use of agile and value. Before the analysis of the survey results are provided, a short overview of the respondents characteristics shall be illustrated. This information will be followed by the factor analysis that will cluster the many variables from the survey (in the way they were clustered at the end of the

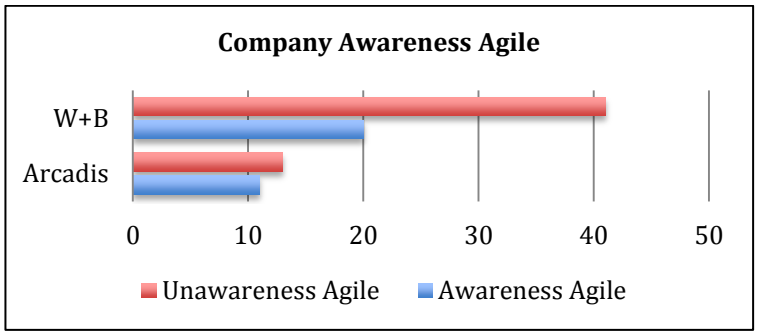
literature review). Additionally a correlation analysis will be completed for the data to discover the strength of the relations. Lastly a conceptual model will be developed that recapitulates all of agile value outcomes of the survey and case study data.

5.3.1 Respondent Characteristics

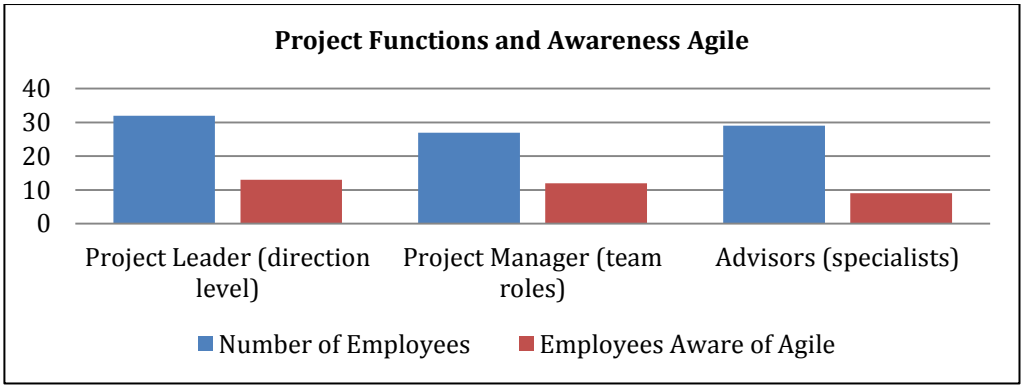
As explained in the section about the set-up of the survey (section 4.2), each respondent was asked to fill in some personal information before choosing one particular project and ranking their project experiences of agile elements and value management. The information was processed in Excel and several charts and diagrams have been made to acknowledge the background of the respondents.



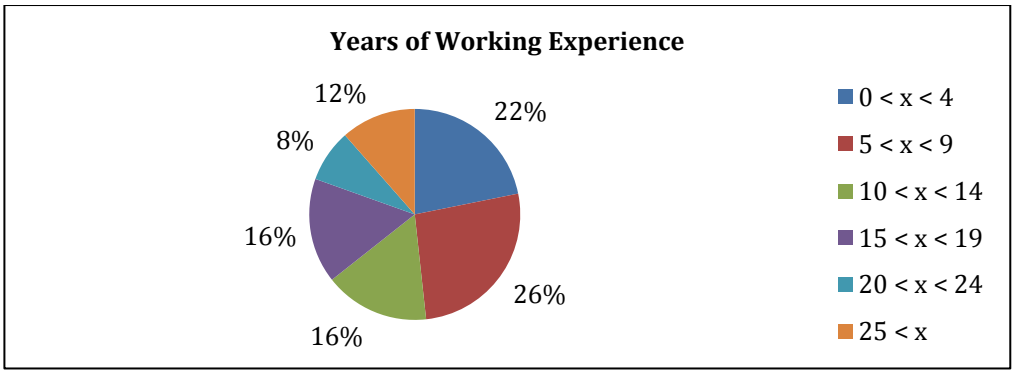
As both charts illustrate, a total of eighty-seven respondents filled in the survey. The left chart shows that the respondents who filled in the survey worked at four different companies. The right chart shows which respondents are already aware of what agile is. As you will be able to see, 62% of the respondents have never heard of agile. As this amount is more than half of the respondents, this outcome should be will be taken into account when analyzing the data. Also as more than half of the respondents haven't heard of agile, this could be an explanation for possible lack of use of agile elements in current practice. Therefore, a right column was added to the survey, portraying personal preference of agile elements. This allowed respondents to also express their opinion on which elements they do find important in practice.



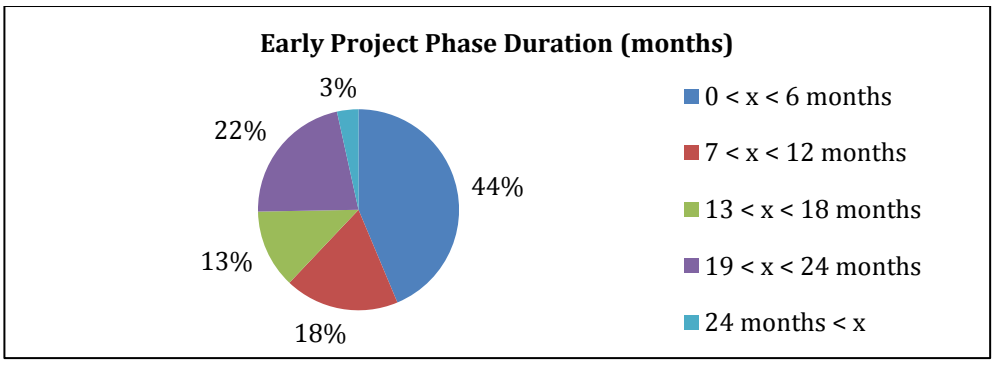
The researcher approached four different companies for the survey. As two of the companies only have one respondent, for comparing the awareness of agile for the companies – these two respondents should be left out when comparing the awareness of agile between the respondent's companies. However, as the results in the chart above show, it will also not be possible to analyze the differences between companies as the amount of respondents is considerably different (approximately thirty and sixty). As the company awareness overview shows, most of the respondents were from Witteveen+Bos. The chart also shows that only half of those respondents had heard and possibly used agile. For the second company this ratio was 50:50. This could indicate that the second company currently implements agile more often and is making their employees aware of this methodology. However, as the amount of respondents is still relatively low for Arcadis, this will not be an accurate conclusion. The conclusion would be more reliable if more respondents completed the survey from the Arcadis.



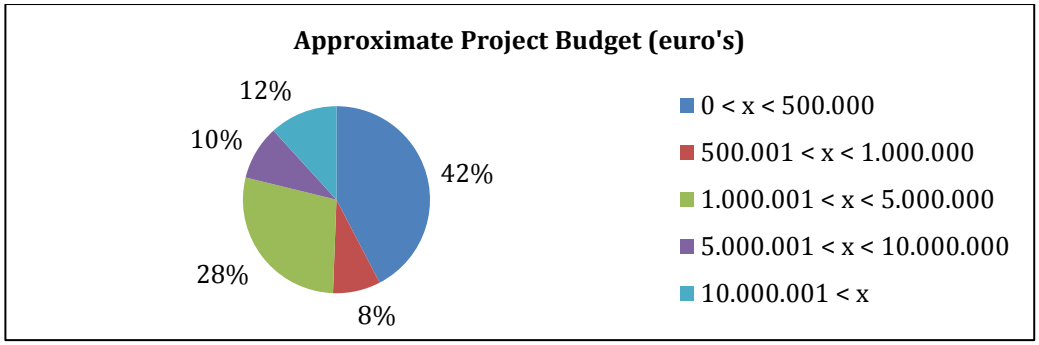
The chart above shows the clusters of all the project functions respondents stated. As there was a substantial amount of sub, assistant, and specific manager roles, it was chosen to group these roles into direction level, team roles and specialists. The grouped roles show that of all the respondents performing at direction level and team roles both have around 30% heard of agile and the remaining 70% have not. For the specialists the awareness rate is a fragment lower.



This chart of the years of working experience shows that a lot of variations were established between respondents. Hence it was chosen to group the respondents into clusters of 4 years. The chart indicates that almost half of the respondents have less than 10 years of experience and 80% of the respondents have less than 20 years of experience. Only 12% of the respondents have over 25 years of working experience.



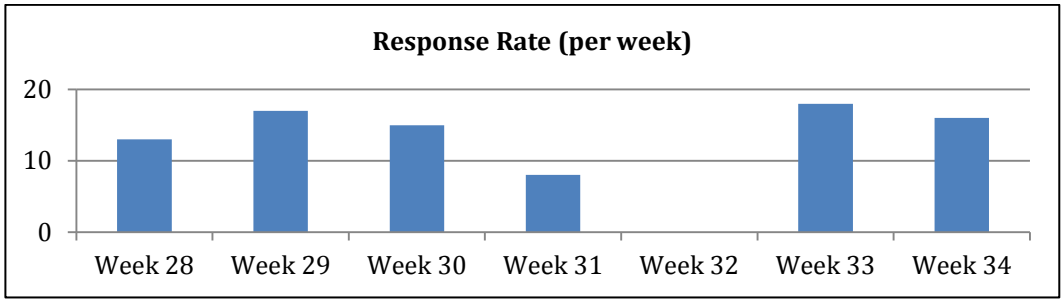
This early project phase chart displays the average amount of time in months taken to complete the project that the respondent kept in mind whilst filling in the survey. The most frequent encountered duration is up to half a year. However this is still less than half of the total amount entered by the respondents. Moreover 62% of the projects entered in the survey took up to a year for the early project phase. Therefore the researcher can conclude that likely most early project phases will commonly take up to a year.



The budget entered by the respondents seemed to be very approximate as everyone rounded up to the nearest round number (1,000; 100,000; 1,000,000 etc.). Additionally two respondents mentioned that they felt uncomfortable in answering this question. The researcher tried to contact them after having filled in the survey. Nevertheless their answer remained the same. Therefore this results chart is based on 85 respondents instead of all 87 respondents. Additionally, some of the figures were noticeably different in comparison with other budgets for 6 months of 2 years. This could be an indication that employees encountered misunderstanding about the budget for the entire project and the budget for the early project phase. Nonetheless it is interesting to see what the general budget was of the projects entered in the survey. Generally, the entered project budgets for half of the projects were up to 1 million euros and 78% up to 5 million euro's. Thus typically, the projects evaluated for the use of agile and value management will take up to one year and have a budget of up to 1 million euros.

5.3.2 Response Rate

The criteria used for the selection of respondents has already been explained in section 4.2. As the researcher provided the survey with face-to-face communication, most of the surveys handed out were also filled in. However not all of them were properly filled in, and had to be left out as otherwise it would disrupt the outcomes of the data analysis. The table below shows the response rate per week. As during the survey data collection it was also summer vacation, the total time for collection of data was 7 weeks. As one will be able to see during week 31 and 32 not a lot of respondents filled in the survey as most employees were on holiday during these two weeks. Therefore it was decided to continue and also spread the survey to more respondents during week 33 and 34.



A total of 109 surveys were given to respondents. In total 14 of these respondents later on replied that they were unable to fill in the survey and help this research and another 8 did not fully complete the survey. Therefore these surveys were left out, as otherwise they would interrupt the final result of the data analysis. In total this provides this research with a response rate of 80% out of the total requested respondents.

5.3.3 Factor Analysis

Factor analysis is commonly used for studies with numerous variables. As 646 relations have been established to be possible with 38 agile elements and 17 value criteria, the study for value relations is relatively complicated. Hence factor analysis will be applied to narrow down the amount of relations. A factor analysis attempts to bring inter-correlated variables together under more general, smaller set of variables, also referred to as factors (B. Williams, Brown, & Onsman, 2012). Thereby specifically reducing the dimensionality of the original set of variables. The

different variables will be analyzed and placed in new sets of variables with their own new space (covering other variables) (Rietveld & van Hout, 1993).

In order to complete a factor analysis, a correlation analysis will also be completed to shown which relations are visible (significant and highly significant). As stated above, the amount of relations will be reduced by looking for variables that correlate highly with a group of other relations. These measures together can measure one underlying variable, which is called a factor (Rietveld & van Hout, 1993). Factor analysis is a method that attempts to identify underlying variables (or factors) that explain the pattern of correlation within a set of observed variables. The factor analysis technique has three main uses (Field, 2009):

1. To understand the structure of a set of variables
2. To construct a questionnaire to measure an underlying variable
3. To reduce a data set to a more manageable size while retaining as much of the original information as possible

Procedure Factor Analysis

A five step procedure should be completed in order to be sure that a factor analysis will be suitable, and also to know how to complete a factor analysis (B. Williams et al., 2012).

1. Is the data suitable for factor analysis?
2. How will the factors be extracted?
3. What criteria will assist in determining factor extraction?
4. Selection of rotational method
5. Interpretation and labelling

Thus, before being able to cluster the variables into the clusters, the requirements for factor analysis must be satisfied. However, as the elements all were retrieved from a literature study, and already arranged according to themes, the reliability through a factor analysis will no longer need to be performed.

The data of all of the agile elements will be clustered according to the nine themes as mentioned in the literature review. Moreover, the value management criteria will also be arranged according to the themes in the literature review, namely: project and process value.

Cluster Type	Cluster Name	Number of elements
Agile Elements	Deliveries	2
	Process	4
	Planning	4
	Teams	9
	Project	4
	Clients	5
	Attitudes	3
	Documentation	3
	Location	4
Value Management	Project Value	5
	Process Value	12

Table 42: Clusters factor analysis

5.3.4 Correlation Analysis

Next, a correlation analysis should be applied in order to assess the relation between two variables. The unit of measurement that should be used is the standard deviation as it is also a measure of the average deviation of the mean. As Field stated, the covariance can be expressed in a standard unit of measurement by dividing by the standard deviation of the two variables (Field, 2009). This standardization is known as the correlation coefficient and is defined by:

$$r = \frac{Cov_{x,y}}{S_x S_y} = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{(N-1)S_x S_y}$$

The two main approaches for correlation coefficients are Pearson's and Spearman's correlation coefficient. Spearman's correlation coefficient can be used when the data has violated parametric assumptions such as non-normally distributed data (Field, 2009). These tests have the assumption of homogeneity of variance. They compare medians rather than means (Assaf & Al-Heijji, 2006). This implies that if the data has outliers, their influence will be cancelled.

In general three types of relations can be distinguished for the correlation coefficient, being (Field, 2009): either no relationship between variables, a negative correlation between the variables (in case one variable increases, the other variable will decrease), or a positive relationship between the variables (in case one variable increases, the other variable will also increase).

Spearman's statistical rank correlation coefficient is measured by rho (r). The correlation coefficient is used to measure and compare the association between rankings of two variables. The formula calculated for Spearman's rho (r) is (Assaf & Al-Heijji, 2006):

$$r = 1 - \left[\frac{(6\sum d^2)}{(n^3 - n)}\right]$$

Its numerical value ranges from -1.0-+1.0. The value provides an indication of the strength of the relationship. In general $r > 0$ indicates a positive relationship, $r < 0$ negative, and $r = 0$ indicates no relationship. The closer the coefficients are to -1 and to 1, the greater the strength of the relationship. As a rule of thumb, the following guidelines on strength of relationships are often applied (Cohen, 1988; Explorable.com, 2009):

Value of r	**Strength of relationship**
0.50 ≤ r ≤ 1.00	Strong
0.30 ≤ r ≤ 0.49	Moderate
0.10 ≤ r ≤ 0.29	Weak
0.00 ≤ r ≤ 0.09	None or very weak

Correlation is an effect size; therefore the strength of the correlation is described using the table as guidance. Moreover, not only the strength of correlation should be considered, but also the significance of correlation. A significant correlation means that the error in the correlation measurement is small enough for a correlation to be considered reliable.

There are generally two levels of significance that can be achieved in a correlation analysis (Field, 2009). The first is P<0.05, which states that the probability of deviating from estimated relationship is less than 5%. The second level of significance used in SPSS is P<0.01, indicating that the probability of deviating from the estimated relationship is less than 1%, and is considered to be highly significant (Campbell, 2013).

Correlation Analysis Main Tables

The two tables showing the correlation analysis for the entire survey have been placed in the appendix, due to the length of the tables (Appendix D1). The figure below illustrates the input data for the data correlation analysis.

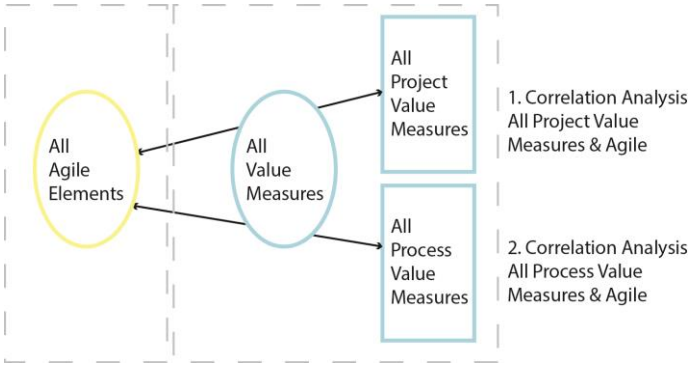


Figure 13: Overview correlation analysis main tables

The first correlation analysis displays all agile elements and the project value criteria. The second correlation analysis table represents all agile elements and the process value criteria. A total of 94 significant relations were revealed out of the total of 646 possible relations, indicating that nearly 15% of the agile elements in current practice have a relationship with value of projects and project processes. The 94 relations can be split up into 56 significant relations and 38 highly significant relations. For the analysis per factor cluster, both significant and highly significant relations will be taken into consideration and explained. Due to the large number of relations that mostly have a weak till moderate relation, only the highly significant relations will be taken into account. The highly significant relations indicate that out of the provided results from the respondents, the probability of deviating from the estimated relationship is less than 1%.

Correlation analysis for the clusters

The correlation analysis in the following section will be based on the factor analysis clusters as previously developed. The figure below illustrates the input for the two correlation analysis that will be explored. Firstly the project value cluster will be correlated with all of the agile clusters, followed by the process value cluster being correlated with all of the agile elements.

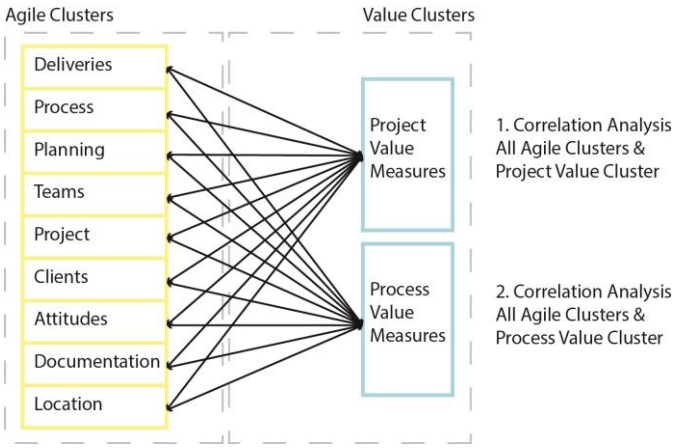


Figure 14: Overview correlation analysis clusters

As the figure shows, the analysis has been split up into project and process value. Afterwards, the elements within each cluster will also be analyzed. The results of the correlation analysis will be provided below.

1. **Correlation analysis all agile clusters & project value cluster**
   All of the elements were clustered into the themes as provided in the literature review and were correlated with the project value cluster. The table in the appendix displays the highly- and significant relations in detail (Appendix D2). Only the highly significant relations will be taken into account for the development of the model based on all results.

   For this correlation, only one of the clusters had a highly significant relationship, namely the agile deliveries cluster with project value. The strength of the relationship was also the only one to be moderate. All of the other relations were weak or very weak. The last elements being location and project value, illustrated to have almost no relationship. The significance as well as the coefficient was almost negligible. These results indicate that only one agile cluster is related to project value.

2. **Correlation analysis all agile clusters & process value cluster**
   The agile clusters as previously established in the literature review were correlated to the process value cluster in this section. The table in Appendix D2 shows the results of the highly- and significant relations in terms of a ranking.

   Five out of the nine clusters had a highly significant correlation with process value, namely: teams, attitudes, documentation, process and project. All of the relations had a moderate strength. The other four relations were weak.

Correlation analysis for the elements in the clusters

As the correlation analysis above only illustrates the main relationship between value management and agile, it will also be important to analyze the elements within each cluster. Therefore, this section will analyze each of the clusters and the elements included in them. The figure below shows the order of the analysis.

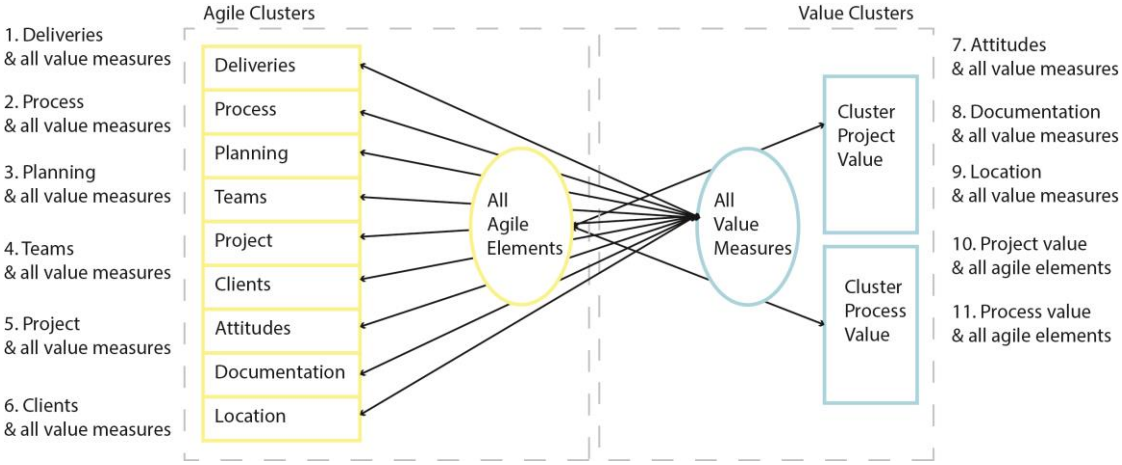


Figure 15: Overview correlation analysis clusters

As the figure shows, eleven correlation analyses will be performed in order to clearly understand which elements within each cluster are important results to use when developing the model for implementation of agile project management in the next section.

1. **Correlation analysis deliveries cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements deliveries cluster and all value measures were ranked. The table in Appendix D2 showed that only one out of the two elements included in the deliveries cluster had a highly significant relation with value, namely: early and frequent deliveries with value of project scope (see table in appendix D2). The relationship has a moderate strength. Another five significant relations were considered with value, however as they were not highly significant and all weak, they will not be included in developing the model.

2. **Correlation analysis process cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements process cluster and all value measures were ranked. The table in Appendix D2 shows that three of the agile elements have a highly significant relation with value measures. The elements evolutionary development that aims to continuously improve has a highly significant relation with both a project and a process value measure. The project measure is scope and for process teamwork is identified. The third relation was found in modifying aims and planning accordingly with the process value of communication.

   Another eight relations were established with a significant but weak relationship. Seven of these relations were found in process values and only one relation was found between agile and project value. However, as these relations were not highly significant, they will not be used in the development of the model.

3. **Correlation analysis planning cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements planning cluster and all value measures were ranked. The table in Appendix D2 shows that only one highly significant relation can be found. The relation between planning and value is found. Regularly revising the planning and re-prioritizing was established to have a highly significant and moderate relation with the process value performance information. Another three significant relations were found also with

a moderate relation. Two of the relations were found with the process value communication and one with the project value costs.

4. **Correlation analysis teams and value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements teams cluster and all value measures were ranked. The table in the appendix (Appendix D2) illustrates the results.

   A total of twenty-six significant and highly significant relations were established between teams and value measures. Eleven of these relations had a highly significant relation. One of these relations was very strong, namely: spreading information and updates at all times with the process value resources. Another eight moderate relations were established. The same agile element with a strong relation was also considered to have a moderate relation with the process value communication. The process value communication also had a moderate relation with organizing daily stands. Moreover a moderate relation with individual attitudes was found in organizing evaluation sessions with the team and encouraging a good collaboration. Encouraging a good collaboration was also established to have a relation with the process value of teamwork and scope. Additionally, the element had a moderate relation with interim client and stakeholder satisfaction. Furthermore, self-management had a moderate relation with change management.

   Another two highly significant weak relations were established. The first one being a cross-functional team correlated with the process value of teamwork. Followed by self-management of teams and the process value of individual attitudes. The remaining fifteen relations were all weak and only had a significant relation. Therefore these relations will not be used to develop the model for implementing agile project management.

5. **Correlation analysis project cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements project cluster and all value measures were ranked. The table in the appendix illustrates all of the results (Appendix D2). This section discusses the results that are also taken into account for the development of the model. A total of thirteen significant and highly significant relations were established. Three relations between the agile elements from the project cluster had a moderate strength highly significant relationship with value measures. Continuously focusing on improving and dividing the project up into smaller do-able projects was related to the process value of teamwork. The agile element dividing the project up was also moderately related to the value of change management. The fourth highly significant relation had a weak strength, namely: simplifying the project by completing smaller projects and the value of change management. The other nine relations were all weak and only had a significant relation. Therefore they will not be taken into account for developing the model.

6. **Correlation analysis clients cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements clients cluster and all value measures were ranked. The table in the appendix displays all of the results (Appendix D2). In total five relations that were either significant or highly significant were established. One of the highly significant relations had a moderate strength, namely: the collaboration with the client and the value of teamwork. The same agile element also had a weak highly significant relation with the value of resources. The other remaining three relations didn't have a highly significant relation and will therefore not be included in the model.

7. **Correlation analysis attitude cluster and all value measures**
   In this section, again on the basis of both significant and highly significant correlations between agile elements attitudes cluster and all value measures were ranked. The table in the appendix illustrates all of the results (Appendix D2). The section below will only describe the results that will also be taken into account for the development of the model. Sixteen significant and highly significant relations were established in total.

Seven agile elements had a highly significant relation with value measures. All of these relations were also of moderate strength. The agile element of employees helping each other was related to the process value of teamwork, individual attitudes, resources, and change management. The agile element of employees trusting each other was related to the process value of teamwork and individual attitudes. The third agile element was that the project evolves around motivated people, which was related to the process value of teamwork. The other nine agile elements had a significant and weak relation and will therefore not be included in the model.

8. **Correlation analysis documentation cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between the agile elements documentation cluster and all value measures were ranked. The table in the appendix illustrates all the results (Appendix D2). The highly significant results discussed below will also be taken into account for developing the model. Nine agile elements had a significant or highly significant relation with value measures. Four of these relations had a moderate strength and were highly significant. The agile element avoiding long and detailed reports and minimizing documentation was related to the value measures project client satisfaction and the process value measures interim client and stakeholder satisfaction and individual attitudes. The other five relations were all only significant and mostly weak, and will therefore not be included in the model.

9. **Correlation analysis location cluster and all value measures**
   In this section, on the basis of both significant and highly significant correlations between agile elements location cluster and all value measures were ranked. The table in the appendix illustrates all of the results (Appendix D2). The correlation analysis of the agile location cluster and all of the value measures only resulted in one weak and significant relation, namely: open workplaces that encourage collaboration and the value of teamwork. However, as the relation is weak and only significant it will therefore not be included in developing the model.

10. **Correlation analysis project value cluster and all agile elements**
    In this section, on the basis of both significant and highly significant correlations between the project value cluster and all agile elements were ranked. The table in the appendix illustrates all of the results (Appendix D2). In total seventeen relations were established to be significant or highly significant between project value and agile elements. Only three of these relations were also established to be highly significant. The value of project scope is highly significantly related to evolutionary development that aims to improve continuously and also early and frequent deliveries. Another project value measure that is highly significantly related to agile is client satisfaction to avoiding long and detailed reports.

11. **Correlation analysis process value and all agile elements**
    In this section, on the basis of both significant and highly significant correlations between the process value cluster and all agile elements were ranked. The table in the appendix illustrates all of the results (Appendix D2). A total of seventy-three relations were either significant or highly significant were established between process value and project value. Thirty-two of these relations were highly significant, from which seven had a weak relationship, twenty-five had a moderate relationship and one had a strong relationship. The other thirty-nine process value and agile elements relationships all had a weak relationship and were only significantly related, and will therefore not be taken into account during the development of the model for implementing agile project management.

    The only strong process value relation with agile was found in spreading information and updates (resource value). The process value of interim clients and stakeholder satisfaction was related to three agile elements, namely: avoiding long and detailed reports, minimizing documentation and encouraging a good collaboration. The project value of teamwork was found to be related to the agile elements employees helping each other, encouraging a good collaboration, employees trusting each other, a project that evolves around motivated people, the collaboration with the client, continuously

focusing on improving, dividing the project up into smaller do-able projects and evolutionary development that aims to continuously improve. Moreover the process value of resources was related to employees helping each other. The value of performance information was related to avoiding long and detailed reports. Moreover the value of process scope was related to encouraging a good collaboration. Also, the process value of communication was related to spreading information and updates, organizing daily stands and modifying the aims and planning accordingly. Another relationship between process value and agile was found in individual attitudes. The value was related to employees helping each other, avoiding long and detailed reports, organizing evaluation sessions and encouraging a good collaboration. Lastly another moderate relationship was found between change management and agile elements. The value measure was related to self-management attitudes, employees helping each other and dividing the project up into smaller do-able projects.

Another seven relations between process value and agile were found to have a weak strength. The process value of teamwork was weakly related to open workplaces that encourage collaboration and cross-functional teams. The value of resources was found to be weakly related to the collaboration with the client, and performance information with regularly revising the planning and re-prioritizing. Moreover, individual attitudes were weakly related to self-management and communication to avoiding long and detailed reports. Lastly, the process criteria change management was weakly related to simplifying the project by completing smaller projects.

Overview of the correlation analysis

As the previous section has provided many tables, it will be necessary to provide an overview of all of the results in order to develop a clear understanding of the relation between agile and value management. Firstly, an overview of the cluster outcomes will be provided, followed by a more detailed overview of the specific value measures in relation to the agile clusters.

Agile Theme Cluster	Project Value	Process Value
Deliveries	√	-
Process	-	√
Planning	-	-
Teams	-	√
Project	-	√
Clients	-	-
Attitude	-	√
Documentation	-	√
Location	-	-

Table 43: Main agile and value cluster correlation analysis results

As the table shows, the agile elements related to deliveries is the only cluster that has a highly significant correlation with project value. The process, teams, project, attitudes, and documentation cluster are all highly significantly correlated with process value. None of the clusters are high significantly correlated to both types of value measures. Instead, three of the clusters (planning, clients, and location) do not show a highly significant relation with any of the two value clusters.

The table below will specify the highly significant relations found between all of the nine agile clusters and two value management clusters. The amount of correlations will be ranked, in order to identify which cluster has the most and correlation with project of project process value.

#	Ranking Agile Clusters	Project Value	Process Value
1	Teams	-	11
2	Attitude	-	7
3	Documentation	1	4

4	Project	-	4
5	Process	1	2
6	Clients	-	2
7	Deliveries	1	-
8	Planning	-	1
9	Location	-	1

Table 44: Ranking number of value correlations with the agile clusters

As the previous table (table 44) has already identified, most of the correlations between value and agile around found in the value of project processes. The most correlations are found within the agile teams cluster and project process value, in which eleven different relations with process value was established. The least correlation is found for the deliveries, planning, and location agile cluster where only one highly significant correlation was established. For deliveries project scope value, planning and process performance information, and location and process teamwork value was established.

As it will be interesting to see which agile clusters correlation with which value measurement criteria, the table below will summarize all of the highly significant correlations established in the data analysis of the survey results.

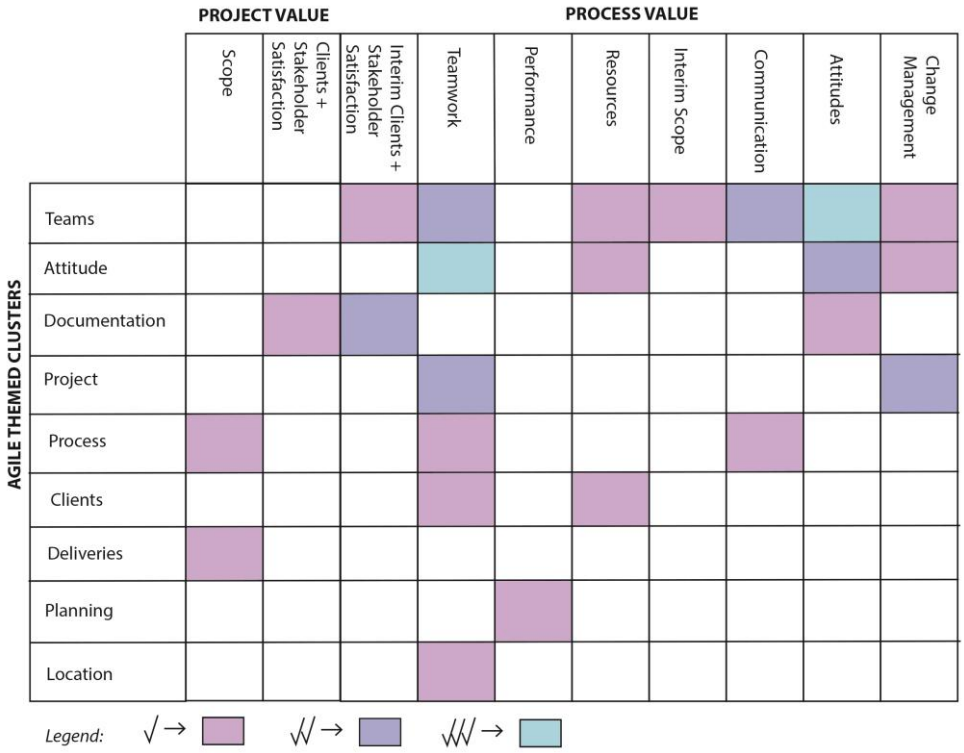


Figure 16: Identifying the highly significant correlations for each agile cluster

All of the nine agile clusters have at least one highly significant correlation with a value management cluster. Out of the five project value measures, only two of the criteria have a highly significant correlation with an agile cluster. The project value criteria costs, time, and quality have been left out of the table, as they do not have a highly significant correlation with any of the agile clusters. For project process value, four out of the twelve value measures were also not mentioned to have a highly significant correlation with any of the agile clusters, namely: scheduling, budgeting, risks, and quality. As the table shows, the project process value criteria that have the most highly significant correlations are teamwork, attitudes and change management.

As now value of agile has been established, the next section will focus on the added as well as lost value of agile project management. Additionally, the principles necessary for implementing agile project management in the construction industry shall be provided.

5.4 Developing the Model for Agile in the Construction Industry

In order to develop the model for implementing agile project management in the construction industry, four distinct steps will be taken. Firstly the correlation analysis results will provide which agile elements have a highly significant relation with value management in current practice. This will be followed by the identification of the case study results that provide opportunities and problems in current project management. These results will be analyzed with the agile elements in order to establish how the opportunities and problems can be solved using agile project management. Thirdly, an overview with all of these results will be provided that will then allow the researcher to compare the results and discuss how added and lost value can be taken from the overview. This will result in a final overview of added and lost value of agile project management in the construction industry, followed by the principles that identify how the methodology should be implemented.

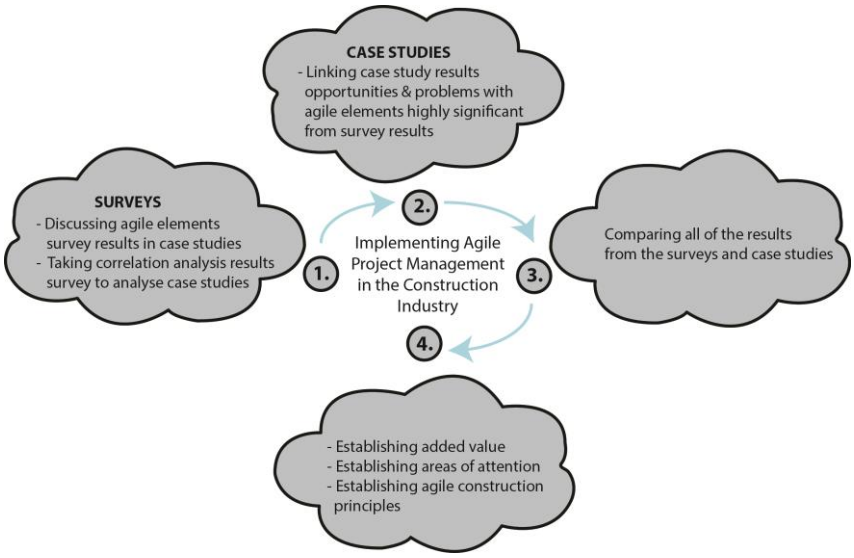


Figure 17: Procedure of developing the model

The first part of the first step was provided in the previous section, in figure 16. In this figure the results from the correlation between the agile elements and value measures are provided. Before step two is engaged upon, firstly the discussion of the agile elements in the survey will be provided. During the case studies, the respondents were asked to share their opinions on the agile elements and provide an insight into which elements should possible be altered. Likewise opportunities for the construction industry was discussed. This will provide additional insights for the outcomes of the survey analysis. Hence possible misunderstandings through the way the agile elements were formulated can prevented through these discussions.

Step 1: Discussing Survey Results Agile Elements Current Practice

At the end of the case study interviews, the respondents were questioned about their survey results. For each case study at least half of the interviewees completed the survey prior to the interview. For each individual case study description, the combined result discussions of the interviewees are displayed. For an in-depth review of the discussion Appendix C1-C6 can be viewed. In total these were broken down into 32 discussion statements. These statements have been organized in the table below. The right column of the table indicates in which case study the discussion was identified. Following this table, the discussions will be organized into two tables. The first table will elaborate on the critiques from current practice provided for the agile elements in the survey taken from literature. Afterwards the next table will illustrate possible opportunities for agile elements that were recognized by the respondents for current practice. Nonetheless it is important to keep in mind that these outcomes are based on opinions and will not be decisive for the final outcome in the model. Instead these opinions will guide the outcome and explain possible alterations.

Agile Element Theme	Discussion of survey outcomes (project experience and personal opinion)	Case Study				
		1	2	3	4	5
Deliveries	There is no standard frequency of exact product deliveries as this depends on the positioning of the project progress in the planning.	√		√		
	For busy project phases design cycle deliveries can occur approximately every 4-6 weeks (milestones) for either the client or internal use.	√		√		
	Evaluating crucial products should be performed more in order to receive feedback from the client and guide the expectations.	√				
Process	Evaluating regularly is not something we do, however we should start doing this more often.			√		√
	More evaluations should be completed more often however only evaluate the necessary products (not every delivery); otherwise evaluations will lose their desired effect.	√	√		√	
	An iterative process should be encouraged.			√		
	By evaluating should be done more often in order to be able to make alternations to products more easily and on time in order to successfully meet requirements.	√				
Planning	Daily stands are too often and will often be unnecessary in projects as they often take up many months and the work is not always sufficient for daily stand ups.	√	√	√	√	√
	Reprioritizing activities is not something we have experience in. We discuss the end goal but do not reprioritize. This should be tried out.			√		
Teams	The available project rooms are often insufficient to host the entire project team. Therefore teams often work off-site.	√				
	If the available space stays limited, set times for each sub team to claim the project room should be organized – this forces people to work on-site.	√				
	Splitting up into smaller project teams has been experienced as working well (better communication, more efficient, better collaboration.)		√			√
	Weekly stands on a regular basis should be implemented right from the start of a project and not as emergency option. Daily stands are too much and will be a waste as people should get the chance to finish their work.	√		√	√	√
	Face-to-face communication often lacks in projects. Nonetheless it is very important for trust, teamwork and motivation and should therefore be acted on more strictly.	√				
	Face-to-face communication only works within small teams as otherwise it often becomes too difficult to organize with everyone's schedule as well as too expensive to host.		√			
	Information management and updating the entire team is often not completed correctly. More efforts should be spent on updating everyone about necessary progress of the project (e.g. newsletter, entire project meetings).				√	√
	Information and updates should not be spread continuously, instead only when necessary and at set times.			√		√
	Team evaluations tend to be sporadically and informal. Evaluations for the teams should be organized on a regular basis both formally and informal.	√			√	

	Evaluation sessions are rarely organized. It would be better to organize this more often (and regularly).			√		√
	A form of hierarchy should always remain in projects and complete self-management will not be good, as people need to know who to turn to when they have questions/concerns.		√			
Project	Do not accept changes to products at all times. In between design loops will be fine but not when you are in a design loop as you should be able to work towards the goal. Hard deadlines should be set for accepting changes.		√			√
Clients	It will be irrelevant for the client to join each project session, as the client will not always have the knowledge, time, or interest to be included in every in between step. Specialists should also be given the time to complete work.		√	√		
	The clients should only be invited to planning sessions when necessary, however this should be done regularly. For example, at the start of every project phase (circa every 6 weeks).	√		√	√	
	Evaluation sessions also with the clients should be performed throughout the project and right from the beginning, not only towards the end.	√		√		
	The client can only work on location if this is also benefits them. This should not be always, instead at set times.	√		√		
Mentality	//					
Documentation	Avoid long and detailed documents when possible instead provide the information in a concise manner to the client.	√			√	
	Planning should definitely be performed for the short term (up to 2 months ahead), however always in combination with the long term planning as you are working towards a goal, which you should not lose out of sight.	√	√	√	√	√
	Documentation should only be minimized in terms of sub-PMP's and if no information is lost. A better balance should be found in when extensive documentation is necessary and when documentation can be minimized.	√	√	√	√	
	Project teams should start working at the same location more often as this is better for the overall teamwork, communication, and spreading of updates.	√		√		
	More open workspaces should be encouraged as this enables project team members to work together more easily and openly.	√			√	
Location	Color-coding should be completed more appropriately to structure the planning visual sheets.				√	
	A project room should be large enough with enough desks in order for teams to work.	√		√	√	

Table 45: Discussions survey results respondents case studies

Overall, only one of the discussions was based on an agile element already being implemented, namely: forming smaller teams instead of one large team. This was recognized in all of the project organization figures of the case studies (Appendix C1-C5). Additionally, only one agile elements theme was not discussed in any of the case studies, namely: individual mentality. This is an interesting observation as during the interviews quite some problems and opportunities were identified related to individual mentality. However, in the survey which was filled in by a lot of other respondents next to the ones that were interviewed, this element was viewed to be important.

In this section, through project experience, the case study respondents explained how certain agile elements could be altered in order for them to be more applicable to the construction industry.

In total only two discussions were repeated in all case studies. The first one related to planning, namely: daily stands are used to guide the project scheduling. Criticism regarding this element was that daily stands are too frequent and will be unnecessary in projects, as they often take up many months and the work is not always sufficient for daily stand ups. The second discussion regarded documentation, namely: only plan for the short term. The discussion that arose was that the short term planning could never be the only type of planning, as the project team should never lose the project aim out of sight. Nonetheless, short term planning is important to get an insight into what should be completed in the near future. However, this was the meaning of the original statement, but due to the way it was written confusions were recognized. The discussions of the two statements recognized in all case studies are concluded to be applicable for each type of project and will be taken into account when the model for implementation of agile project management in the construction industry is developed.

Two other discussions were recognized in all of the case studies except for the completed highway project. The first one was related to teams, namely regarding the agile element: daily stands are organized within and also outside of each project team (discipline). Again the critique was based on the daily stands as this would not provide the specialists with enough time to complete their work. In the other four case studies the weekly stands were often sporadically organized (especially during the summer holidays), and also not within each discipline. The second discussion that emerged was related to documentation, namely: minimize documentation. The critique was recognized in all case studies except for the shortest running dike project. Respondents mentioned that documentation often couldn't be minimized, as legal documents will always exist for infrastructure projects. Once things change within projects and discussions emerge, the project team will want to be able to relate back to requirements/scope that was written out in documents sent and accepted by the client. Nonetheless a better balance between when documentation can be minimized and when it cannot – should be found. An example of minimizing documentation is by developing sub-PMP's for each project phase. Currently most project teams establish one PMP, which is updated after each phase – as you will not be able to plan ahead for years. A solution for this would be to establish minimized PMP's for each phase.

Moreover, another three agile elements were discussed in the same manner in three different case studies. The first one being: evaluations are completed after each delivery. The respondents in the two longest already completed projects and the partially running dike project agree that more deliveries should be evaluated, as this is currently not being completed. However, evaluations should only be completed for necessary products and not for every delivery; otherwise evaluations will lose their desired effect. The second element discussed in the longest and completed dike project, completed bridge project, and partially running dike project was: the client is involved in scheduling sessions. In order for the client not to disturb the project progress, and also for the involvement to stay interesting to the client, the client should only be invited to scheduling sessions when this is also necessary. Nonetheless, these sessions with the client should be organized on a more regular basis – for example at the start of each design loop. Moreover, the respondents from the same projects also discussed the project rooms, as they are generally not suitable for project teams currently. However, if the capacity of the room were to be satisfying, then the project rooms should be used regularly.

Another five elements were discussed in two different projects. The first one being related to deliveries, namely: frequent deliveries to the client approximately every 4 weeks. The critique provided by the respondents from the longest completed project and the completed bridge project was that the deliveries to the client couldn't be regulated as this depends on the project phase. Sometimes it will be a very busy period close to a milestone when a lot of products are delivered to the client. However, once the products have been delivered and are up for revision by the client, there will be a period without any deliveries. Nonetheless when and if necessary, the respondents mentioned an average of delivering every six weeks would be appropriate, and every four weeks in the case of busy project periods. The next element was related to teams, namely: always update project members and spread information. The critique provided was that it would be too chaotic to continuously update the project members. Instead, set times should be provided to update the team. Another agile element that was discussed was related to projects, namely: continuously be open to changes. The respondents from the completed highway project and running dike project responded that the project team should not accept changes to products

at all times as this would obstruct the development of the product. Instead, changes should only be accepted in between design loops at set times. Once the project team is engaged in a design loop, changes should not be considered, as the aim should then be to work towards the goal. Hard deadlines should be set for accepting changes in order for the changes not to obstruct the project process. Moreover, two elements regarding clients were also discussed. The first one being: the client is involved in every step of the project process. The respondents agreed that it would be irrelevant for the client to join each session, as the client will not always have the time, knowledge, or interest to be included in every step in between products. In addition, the respondents added that specialists should also be given the time to be able to complete their work. The second element was: the client works on-site. Likewise, the respondents reacted that this should only be the case if it is also beneficial for the client. Therefore, this will likely not be all the time, instead set times should be made available for the client to work on-site. In this way, specialists will also be provided the chance to work on their products without continuous feedback.

Another two elements were recognized in the completed highway case study by the same project member (assistant core team). Therefore these two critiques have been considered to likely not occur in all projects all the time. The first one being related to teams: face-to-face communication is always encouraged instead of email/skype. The respondents critique was that face-to-face communication only works well in small teams. Encouraging face-to-face communication in larger teams will become too difficult as everyone has different schedules, as well as too expensive to host. Secondly another agile element from teams was criticized, namely: self-management of teams. The respondent argued that a form of hierarchy should always remain in projects and complete self-management will be insufficient. Project members should know who they can turn to when they have questions or concerns.

Theme	**Survey agile element**	**Interview results survey agile element**	**Occurrence**
Planning	Daily stands are used to guide the project scheduling.	Weekly stands are used to guide the planning, during necessary project phases.	High
Documentation	Only plan for the short term.	Short term planning should be performed up to two months ahead in combination with the long term planning.	High
Teams	Daily stands are organized within and also outside of each project team (discipline).	Weekly stands on a regular basis should be implemented right from the start of a project and not as emergency option.	High
Documentation	Minimize documentation.	Documentation should only be minimized in terms of sub-PMP's and if no information is lost.	High
Process	Evaluations are completed after each delivery.	Only evaluate all critical deliveries.	High
Clients	The client is involved in scheduling sessions.	The client should regularly only be involved in the scheduling sessions organized at the beginning of each design loop.	High
Deliveries	Frequent deliveries to the client every 4-6 weeks.	Deliveries to the client cannot be regulated as this depends on the project phase.	Medium
Teams	Always update project members and spread information.	Instead of updating continuously, only update the project team at set times.	Medium
Project	Continuously be open to changes.	Only be open to changes in between design loops. Make sure there are hard deadlines for accepting changes.	Medium

Clients	The client is involved in every step of the project process.	Only involve the client in project sessions that will also be interesting for the client. For example in between design loops.	Medium
Clients	The client works on-site.	The client is only invited to work on-site at set times.	Medium
Teams	Face-to-face communication is always encouraged instead of email/skype.	Face-to-face communication is only always encouraged within the sub-teams of projects.	Low
Teams	Self-management of teams.	A form of hierarchy in combination with self-management of sub-teams.	Low

Table 46: Results discussions survey in case study interviews

In addition to the critique of some of the agile elements, other elements in the way they are already formulated were also considered to be an opportunity for future projects. In the following section, these opportunities will be discussed, concluded by a table identifying the agile elements and summaries of the opportunities. The first elements from the case study results list that was proposed as an opportunity for agile project management in the construction industry was: project rooms should be used where important project documents are permanently located (i.e. project scheduling). The discussion that arose was that the project rooms are often not appropriate to hold the weekly stands and work permanently with the project team. Therefore this should firstly be improved before people will be able to work on-site. If the rooms were to be appropriately allocated the respondents agreed that teams should definitely start working on location more, as this has proven to improve teamwork and communication. In case the project room is not sufficient for the entire team, schedules should be made for the project room (when each discipline will be able to use the project room).

The next agile element considered to be an opportunity was: evaluations are completed after each delivery. Currently not a lot of deliveries are evaluated; instead an overall phase (and all deliveries within that phase) or the completion of a project is often evaluated. The respondents from completed bridge project and the running dike project recognized this as an opportunity to minimize reworks.

Next two elements for teams were recognized as opportunities. Firstly, always updating project members and spreading information. Currently this is often not communicated properly, resulting in documents with different information regarding the same products. This should be encouraged more and updates should be sent out to the entire team as well as project information about each discipline. Moreover another opportunity was established in the following agile element: evaluation sessions within the team are regularly organized. Currently, team evaluations tend to be sporadically and informal. However, the respondents recognized that evaluations are important in order to learn throughout the project process and be able to act on mistakes or strengths during upcoming project phases. Therefore evaluations for the teams should be organized on a regular basis both formally and informal. Also, regarding the same agile element respondents from the third and fifth case study recognized that even though the evaluations are sometimes sporadically organized, in most projects they are not organized at all. Thus, the respondents would want to evaluate teams in future projects.

Moreover the opportunity found in the next agile elements regarding clients was that sessions should be organized with the client right from the start of the project. Often, the client sessions are organized only in later project phases. It would be more beneficial to organize these regularly, in order to provide regular feedback, right from the beginning.

Also within the element regarding minimizing documentation, an opportunity was found. Team members should be encouraged more to avoid long and detailed reports when this is possible. Instead the project teams should provide the information in their products in a more concise manner to the client.
Another two opportunities were discussed regarding location. The first one was related to involved parties should work on-site. The respondents recognized that project teams should be

encouraged more to start working at the same location as this is beneficial for the overall teamwork, communication, and spreading of updates. Additionally, an opportunity was discussed regarding open workspaces that encourage collaboration. The respondents agreed that more open workspaces should be encouraged as this enables the project team members to work together more easily and openly. It could be good for the overall teamwork.

Furthermore an opportunity was also seen by half of the respondents in the completed highway project regarding: frequent deliveries to the client every 4 weeks. The respondents mentioned that evaluating for crucial products should be performed more often in order to receive feedback from the client and guide the expectations.

Another element that was considered in the completed bridge case study as an opportunity for future projects was: frequent deliveries in an iterative process. The element was recognized by the project manager as well as the value engineer advisor. Both considered a more iterative process in projects to be beneficial.

Moreover, the last agile element considered as an opportunity to relatively occur was: color-coding is applied. Two respondents (project leader and project manager) mentioned this method to be an opportunity for future projects. The respondents mentioned that color-coding should be completed more appropriately in order to structure the planning visual sheets.
Another five opportunities were considered by one respondent in one case study. Four of these were all considered in the completed highway case study by the assistant of the core team. The first one related to process (evaluations are completed after each delivery). The respondent mentioned that evaluating should be done more often to ensure alterations of products can be processed more easily as well as on time in order to still meet the clients' requirements successfully. The second element was: team work at the same location. The respondent mentioned that the project rooms are often insufficient to be able to host the project team. Therefore improvements in the project rooms should be made for future projects. Thirdly, also regarding the same element the respondent mentioned that if the available space for the project rooms were to stay limited, alternatives should be considered. Project room schedules should be established for each sub-team in order to force the teams more to work on-site. Fourthly, another element mentioned as an opportunity by the respondent was related to face-to-face communication is always encouraged instead of email/skype. The respondent mentioned that face-to-face communication is something that often lacks in projects but should be encouraged more as it is very important for trust, teamwork and motivation. Therefore the project teams should be encouraged to apply face-to-face communication more strictly.

The last element recognized as an opportunity was recognized by the project manager in the partially running dike case study. The opportunity regarded the element: revise original scheduling by reprioritizing activities. The project management mentioned that reprioritizing activities is not something completed in current practice. The end goal is discussed, but no reprioritizing takes place after. The respondent mentioned to want to try this out in future projects.

This table below summarizes the discussion from the previous pages. All of the high and medium occurrence opportunities have been mentioned in either more case studies, by important project roles, or more than half of the case study respondents. The low occurrence opportunities have only been mentioned by one respondent in one case study and are therefore less reliable to consider as an accurate opinion for the implementation of the agile element in future projects.

Theme	Survey agile element	Discussion	Occurrence
Location	Project rooms should be used where important project documents are permanently located (e.g. Project scheduling).	Appropriate project rooms should be made available for project teams to be able to permanently hang documents and work on-site.	High
Process	Evaluations are completed after each delivery.	Evaluations should be completed on a regular basis.	Medium

Teams	Always update project members and spread information.	Encourage efforts to update everyone about necessary progress of the project.	Medium
Teams	Evaluation sessions within the team are regularly organized.	Evaluation sessions, both formal and informal, should be organized on a more regular basis.	Medium
Teams	Evaluation sessions within the team are regularly organized.	Encourage organizing evaluation sessions.	Medium
Clients	The client is involved with scheduling sessions.	Encourage evaluation sessions with the client right from the beginning, not only towards the end of a project.	Medium
Documentation	Minimize documentation	Encourage team members to avoid long and detailed documents when possible, and instead provide the information in a concise manner to the client.	Medium
Location	Involved parties should work on-site.	Encourage project teams to start working at the same location on set days.	Medium
Location	Open workspaces encourage collaboration.	Encourage project teams to work in an open workspace environment.	Medium
Deliveries	Frequent deliveries to the client every 4-6 weeks.	Encourage evaluations of crucial products.	Medium
Process	Frequent deliveries are completed through an iterative process.	Encourage an iterative process to deliver more frequently.	Medium
Location	Color-coding is applied.	Encourage structure in the visual management by applying color-coding.	Medium
Process	Evaluations are completed after each delivery.	Alternations are more easily made if products are regularly delivered and evaluated.	Low
Teams	Teams work at the same location.	Ensure better project rooms to allow teams to work on-site.	Low
Teams	Teams work at the same location.	With limited space, develop a project room schedule and allocate each project team with a timeslot.	Low
Teams	Face-to-face communication is always encouraged instead of email/skype.	Face-to-face communication should be acted on more strictly as it improves teamwork.	Low
Planning	Revise original scheduling by reprioritizing activities.	Revise original scheduling by reprioritizing activities.	Low

Table 47: Case study results opportunities implementation agile elements current practice

As mentioned, these outcomes are based on opinions. Hence the outcomes will only guide the outcomes as provided from the correlation analysis for the surveys.

Step 2: Opportunities and Problems Project Management Case Study Results

In the second step for developing the model, the opportunities and problems will be discussed. The cross-case analysis of the interviews for the case study results derived a total of eight opportunities for project management. In the table below these eight opportunities have been stated in the left column, followed by the agile elements in the right column. The agile elements stated in the right column, indicate possible solutions to the opportunities provided by the respondents.

Opportunities current practice project management			Agile elements solutions regarding the opportunities in current practice project management	
1	Hire a team coach who focuses on training employees in more coherent communication, teamwork, and the correct attitudes within the teams.	→	Teams:	Information and updates are always spread throughout the project team
				Encourage a good collaboration with all teams
			Attitude:	The project evolves around motivated people
				Employees help each other
				Employees trust each other
2	Make sure enough time is dedicated to getting to know each other (PSU, PFU, and informal meetings)	→	Teams:	Information and updates are always spread throughout the project team
				Within the team as well as with other teams - daily stands are often organized
				Face-to-face meetings are organized as much as possible
			Attitude:	The project evolves around motivated people
				Employees help each other
				Employees trust each other
3	Spend more time on continuously organizing sessions to update all team members	→	Teams:	Information and updates are always spread throughout the project team
				Within the team as well as with other teams - daily stands are often organized
			Planning:	Regularly revise planning and re-prioritize
			Project:	Throughout the project continuously focus on improving
			Attitude:	Employees help each other
4	Establish periodic audits also at team level	→	Process:	Modify aims and planning accordingly
			Teams:	Evaluation sessions with the team are regularly organized
			Attitude:	Employees help each other
5	Make people aware of their responsibilities also for the bigger picture	→	Planning:	Regularly revise planning and re-prioritize
			Teams:	Self-management attitudes
				The project is organized into many smaller teams
			Location:	Open workplaces encourage collaboration
6	Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project	→	Deliveries:	Early and frequent deliveries
				Focus on frequent deliveries through an iterative process
			Teams:	Evaluation sessions with the team are regularly organized
				Encourage a good collaboration
			Project:	Divide the project up into smaller do-able projects
7	Take more time to determine the project requirements and expectations together	→	Process:	Modify aims and planning accordingly
			Planning:	Integral planning sessions
			Teams:	Within the team as well as with other teams - daily stands are often organized
8	Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project	→	Process:	Evolutionary development that aims to continuously improve
				Modify aims and planning accordingly
			Teams:	Face-to-face meetings are organized as much as possible
			Project:	Simplifying the project by completing smaller projects
			Clients:	The collaboration with the client is highly important

			Documentation:	Avoid long and detailed reports
				Minimize documentation

Table 48: Results opportunities current practice project management linked to agile

As the table shows, all of the opportunities can be linked with the agile elements as provided in the survey. Moreover, all of the opportunities are linked with at least two of the agile themes. All of the elements provided in the table all have a significant and highly significant correlation with value management. In order to establish possibilities for added value, all of the agile elements that react to the opportunities provided will be displayed in an overview table in the next section. This will allow the researcher to analyze which agile elements for opportunities are the same as the significantly correlated elements as well as the solutions for problems in current project management.

Problems Current Project Management			**Agile elements solutions regarding the problems in current practice project management**	
1	Difficulties in finding the right people for the project	→	Teams:	Cross-functional teams
2	Often not enough time is spent together on the same location	→	Teams:	Face-to-face meetings are organized as much as possible
			Project:	Throughout the project continuously focus on improving
			Clients:	The client is involved in evaluation sessions
			Location:	Open workplaces encourage collaboration
3	Often the project team is not provided with proper documents	→	Attitude:	Employees trust each other
				Employees help each other
4	Miscommunications / interpretations and confusions are often caused by different language use within projects	→	Deliveries:	Early and frequent deliveries
			Teams:	Face-to-face meetings are organized as much as possible
			Attitude:	Employees help each other
			Location:	Open workplaces encourage collaboration
5	Schedules are often tight, which makes it almost impossible to follow it accordingly if changes occur	→	Process:	Modify aims and planning accordingly
			Planning:	Regularly revise original planning and re-prioritize activities
			Project:	Divide the project up into smaller do-able projects
				Simplifying the project by completing smaller projects
6	The client is often more than one person. This can result in different opinions on delivered products	→	Clients:	The client is involved with evaluation sessions
7	Sometimes the client's involvement cannot be influenced if the client does not have the time to join team sessions	→	Attitude:	The project evolves around motivated people
8	Specialists often lack skills to communicate their good work appropriately to the client	→	Teams:	Cross-functional teams
9	In case of holidays, scheduling is often too tight and not enough people are available. Changes should be made in the schedules for these periods	→	Process:	Modify aims and planning accordingly
			Planning:	Integral planning sessions
			Attitude:	Employees help each other

Table 49: Results problems current practice project management linked to agile

Likewise, the table above presents the results from the case studies in combination with the agile elements as provided in the survey. The table provides the problems as provided during the case study interviews in the left column and the agile elements providing possible solutions in the right column.

Step 3: Comparing the Survey and Case Study Results

In the third step of developing the model, the results from the previous steps will be compared. As the table shows, most of the problems and opportunities in current practice can be answered with agile elements. The table below provides an overview of which agile elements were considered to have a highly significant relation with value measures, all of the opportunities in current practice project management, as well as all of the possible solutions to the problems in current practice.

Agile Themes	Agile Elements	Highly significant values	Opportunities in Current Practice	Solutions to Problems in Current Practice
Deliveries	Early and frequent deliveries every 4-6 weeks.			√
	Track project deliveries continuously.			
Process	Focus on frequent delivery through an iterative process.		√	
	Evolutionary development that aims to continuously improve.	√	√	
	Evaluations after each delivery.			
	Appropriately adjust the aims and planning.	√	√	√
Planning	Change is welcome even in later phases of the project development.			
	Integral planning sessions are applied to encourage interfaces.		√	√
	Apply daily stands to regulate the project planning.			
	Regularly revise original planning and re-prioritize activities.	√	√	√
Teams	More smaller teams instead of one large team.		√	
	Self-management organization of teams.	√	√	
	Cross-functional teams.	√		√
	Teams work at the same location.			
	Face-to-face meetings are organized as much as possible.		√	√
	Within the team as well as with other teams – daily stands are often organized.	√	√	
	Information and updates are always spread throughout the project team.	√	√	
	Evaluation sessions with the team are often organized.	√	√	
	Encourage a good collaboration with all teams.	√	√	
Project	Always be open to changes in the project.			
	Throughout the project continuously focus on improving.	√	√	√
	Divide the project up into smaller do-able projects.	√	√	√
	Simplify the project by completing several smaller projects.	√	√	√

Clients	The client is involved in each step to be completed in the project process.			
	The client is involved with planning sessions.			
	The client is involved with evaluation sessions.		√	√
	The client also works on-site.			
	The collaboration with the client is highly important.	√	√	
Attitude	The project evolves around motivated people.	√	√	√
	Employees trust each other.	√	√	√
	Employees help each other.	√	√	√
Documentation	Avoid long and detailed reports.	√	√	
	Only plan for the short term.			
	Minimize documentation.	√	√	
Location	Involved parties should work on-site.			
	Open workplaces encourage collaboration.	√	√	√
	Project rooms should be used where important project documents are permanently located (e.g. Project scheduling).			
	Color-coding is applied.			

Table 50: Overview relation case studies and survey results

The left columns of the table above repeat the agile themes and elements as established in the literature review, and as used in the survey research. The third column then identified the highly significant correlations with value criteria, followed by the fourth column that identifies the opportunities in project management, and lastly possible solutions to the problems in project management. All of the opportunities and solutions to problems identified all have a significant or highly significant correlation with the value management criteria.

As the table shows, all of the identified highly significant correlations between values and agile are all recognized as either an opportunity in project management or a solution to problems in project management. The following sections will discuss the added value identified in this table as well as possible lost value of agile project management.

Step 4: Implementing Agile Project Management in the Construction Industry

After having compared the outcomes of the case studies and surveys, the final outcomes can be established that will form the model that will portray how agile project management can be implemented in the construction industry, and add value. The first section shall elaborate on the added value derived when agile project management is implemented in the construction industry. Following, areas of attention when implementing agile project management will be acknowledged. Lastly, the revised principles that explain how to implement agile project management in the construction industry will be presented.

5.4.1 Establishing Added Value

In order to be able to establish the added value of agile project management in the construction industry, the value of agile was be compared to the opportunities and problems in current project management. As the case study results have shown, the respondents have identified value in projects when the project aim is realized. Additionally some of the respondents have mentioned that the aim should also be reached within the time and budget provided, in order for the project to be valuable. Moreover the respondents have also stated that added value in a project is developed by creating optimal solutions that exceed the client's expectations. Additionally, an adequate focus on the project process is able to establish added value. As the survey results have shown, most of the value criteria related to agile elements (except for one) were found in the process of a project. This outcome is verified in both research methods and indicates that the respondents agree to focus more on the project process when implementing

agile project management, in order to achieve added value. Within the value of the process, in order to achieve added value the client's expectation will need to be exceeded. Thus by analyzing which agile elements already have a relationship with process value and which agile elements are able to react on opportunities or problems in current project management, added value will be established. The previous table illustrated which of these agile elements are relevant to take into account. The table below describes the added value of the agile elements in more depth.

#	Ranking	Agile Theme	Agile Element	High significance correlation value criteria
1	High	Process	Appropriately adjust the aims and planning	Process communication
2	High	Planning	Regularly revise original planning and re-prioritize activities	Process performance information
3	High	Project	Throughout the project continuously focus on improving	Process teamwork
4	High	Project	Divide the project up into smaller do-able projects	Process teamwork, process change management
5	High	Project	Simplify the project by completing several smaller projects	Process change management
6	High	Attitude	The project evolves around motivated people	Process teamwork
7	High	Attitude	Employees trust each other	Process individual attitudes, process teamwork
8	High	Attitude	Employees help each other	Process teamwork, process individual attitudes, process resources, process change management
9	High	Location	Open workplaces encourage collaboration	Process teamwork
10	Medium	Process	Evolutionary development that aims to continuously improve	Project scope, process teamwork
11	Medium	Teams	Self-management organization of teams	Process change management, process individual attitudes
12	Medium	Teams	Cross-functional teams	Process teamwork
13	Medium	Teams	Within the team as well as with other teams - daily stands are often organized	Process communication
14	Medium	Teams	Information and updates are always spread throughout the project team.	Process resources, process communication
15	Medium	Teams	Evaluation sessions with the team are often organized	Process individual attitudes,
16	Medium	Teams	Encourage a good collaboration	Process teamwork, interim client and stakeholder satisfaction, process scope, process individual attitudes
17	Medium	Clients	The collaboration with the client is highly important	Process teamwork, process resources
18	Medium	Documentation	Avoid long and detailed reports	Project clients satisfaction, process interim clients and stakeholder satisfaction, process individual attitudes
19	Medium	Documentation	Minimize documentation	Project clients satisfaction

Table 51: Overview ranking added value implementation agile elements

As the table shows, nineteen agile elements have been identified to provide added value of agile project management in the construction industry. The ranking displayed in the table was based on the amount of times the agile element was identified. The elements were given a medium ranking in case the value were only mentioned as an opportunity solution or problem solution, and a high ranking in case the element was mentioned in all of the three columns (highly significant value, opportunity, problem).

5.4.2 Establishing Areas of Attention

In order to establish possible lost value, the main correlation analysis charts (Appendix D1) were used as well as the table identifying the value, opportunities and solutions for current practice project management (Table 50). The correlation tables have provided information about the agile elements and value measurement criteria which have no significant relation. Hence no correlation indicates possible restraints on the implementation of agile project management in the construction industry. The table below illustrates all of these agile elements that have no significant correlation and provides remarks that possibly explain why there is no acceptable correlation coefficient.

Agile Element	Remark
Evaluations after each delivery	Lost value for evaluating every delivery. Not all deliveries are critical.
Change is welcome even in later phases of the project development	Lost value for always accepting changes, they should be regulated.
Apply daily stands to regulate the project planning	Lost value for daily stands, weekly will be more appropriate.
Teams work at the same location	Lost value to always work at the same location.
The client is involved in each step to be completed in the project process	Lost value for always involving, could disturb progress.
The client is involved in planning sessions	Lost value for attendance of all sessions. Only crucial sessions.
The client also works on-site	Lost value, only at set times otherwise irrelevant and progress could be disturbed.
All involved parties should work on-site	Lost value, also not possible for all employees to always work on-site (only set sessions, days).
Project rooms should be used for the entire length of the project with permanent project documentation	Possible lost value. Rooms are often insufficient. If rooms were sufficient then it would maybe work.
Color-coding is applied	Possible lost value. The correlation was almost non-existent.

Table 52: Overview of lost value implementation agile elements

For the first element evaluations after each delivery, respondents have stated that not every delivery is as important as the other. Respondents have indicated that they would like to start implementing interim evaluations in order to guide the project progress more accordingly and receive better indications of possible reworks. However, the evaluations should only be performed after critical deliveries, otherwise evaluations will become an overkill and not be taken serious. The remark of not evaluating every delivery, simply only critical deliveries, was also stated during the discussions on the survey results.

For the second element change is welcome even in later phases of the project development, respondents have indicated that changes prevent the project team from completing the project on time and within budget. Therefore changes should not be welcome at all times (only when regulated). For example, changes could be implemented in between phases.

For the third element applying daily stands, respondents have mentioned that this will simply not be applicable for the type of projects available in the construction industry. Employees often have many different projects next to each other and only spend a few days a week on each project. Therefore daily stands will not be possible as well as necessary. Implementing weekly stands on a regular basis was also part of the discussion of the survey results. The respondents mentioned that weekly would definitely be useful.

For teams working at the same location, respondents have mentioned that this will often not be necessary. For each discipline to work together at the same location at least once a week and for the entire team to work together at the same location at set times (1 day every 2 weeks) will be sufficient.

Next, involving the client in each step of the project process will be too often. Respondents have mentioned that involving the client too often will also not always be relevant for the clients as specialists should be given the appropriate time to able to complete their own tasks. Therefore the client should only be involved if this is also profitable for them. Often during specialist work, they will not have the expertise to also judge the work. In case they would want to be highly involved also during those times, they will have to hire external specialists to judge the progress. Nonetheless, the client should be involved more throughout the process (set times).
The next element, involving the client in planning sessions, currently does not happen for most of the time. Moreover, the client often does not have or want to make the time to attend all planning sessions. Instead they mostly only want to be involved during the crucial planning sessions, as likewise they also have other projects to work on. This could result in the client choosing the wrong dates to join the planning sessions, which are less relevant for them to attend. Additionally, as some of the planning sessions will only be relevant to a particular discipline, it will also not always be necessary for the client to join the planning sessions.
Likewise, the client should not be working on-site at all times. Instead only at set times, as during the times that specialists are completing their work it will be irrelevant for the client to always work on-site. Instead only during crucial weeks or relevant meetings, the clients should be working at the same location as the project teams. Likewise the same discussion arose during the survey discussions. Involving the client more often is something that should be improved, however infrastructure project do not always make it useful for clients to be involved at all times as specialist work is often of less interest to the client.

Moreover, for all the parties to work at the same location will simply be an overkill during most of the project time. During a lot of the project times, it will be irrelevant for all parties to work on-site as specialists should be able to complete their work. Nonetheless, it would be better to encourage and start working together at the same location more often.

The next agile element, project rooms for the entire length of the project with permanent project documentation, is something that is currently not used often. Especially since most of the time the project rooms do not have enough seats and tables for the project team to work there. The space available for the project rooms should firstly be improved to allow the rooms to be used.
For the last element, the correlation coefficient for the color –coding was for both project and process all around 0.01 and 0.08. Therefore illustrating that no particular relation is found between color-coding and value of a project and project process.

In order to make sure if these values should be considered to be an area of attention and a possible lost value of implementing agile project management in the construction industry, the expert panel will be asked to judge these statements.

5.4.3 Establishing Agile Construction Project Management Principles

By comparing the results of the case studies and survey, the principles for the implementation of agile project management in the construction industry were be developed. The input for both the research methods originated from the literature review. Therefore, after providing the list of principles, a comparison will also be made with the original elements and principles as established in the literature review. As the areas of attention and case study results have discussed, some of the agile elements will need to be altered in order to be applicable for the construction industry.

Defining a principle

In order to define principles that will serve as preconditions for the construction industry, firstly a principle will be defined, thereby explaining what principles must entail.

> *A fundamental rule or law of action based upon desirable ends or objectives. A principle is more basic than a policy or a procedure and generally governs both."*
> *(Wideman, 2012)*

A fundamental truth or proposition that serves as a foundation for a system of belief or behavior or for a chain of reasoning.
(OxfordDictionary, 2017)

These above definitions imply that a principle should highlight the most important aspects of a theory that lead to a desirable outcome, as well as explain which actions are anticipated alongside. Hence, the knowledge gathered from the literature study and the research results combined will explain the fundamentals of agile project management.

Agile Construction Industry Principles

As provided in the literature review, the agile principles are based according to the elements established in the nine themes: deliveries, process, planning, project teams, projects, clients, attitudes, documentation, and location. The principles aim to illustrate the most important aspects of the agile project management methodology in order to achieve a desirable outcome that can be implemented in the construction industry.

1. Encourage early and frequent deliveries every four weeks. Critical deliveries should always be delivered to clients.
2. Establish development in an evolutionary manner, that aims to continuously improve. Appropriately adjust the aims and planning when necessary.
3. Ensure that all crucial deliveries are evaluate to promote timely feedback.
4. Welcome changes even in later phases of the project development, however only at set time.
5. Regularly revise the planning and reprioritize activities to encourage continuously improving.
6. Apply regular integral sessions to encourage working at a constant pace.
7. Apply regular weekly stands to regulate the project planning and create awareness.
8. Ensure self-management in project teams, moving away from hierarchical team organizations.
9. Implement cross-functional teams to improve collaboration.
10. Ensure face-to-face meetings as much as possible. Also encourage teams to work on-site.
11. Use the appropriate resources and set regular times to spread information and updates throughout the project team.
12. Regularly organize evaluation sessions with the team throughout the project process to encourage collaboration and continuously improving.
13. Focus on encouraging collaboration within teams as well as with the other project teams to stimulate the project to evolve around motivated people.
14. Simplify the project by dividing it up into smaller do-able projects.
15. Clients are always involved in crucial steps during the project process (i.e. particular planning and evaluation sessions). They are also invited to work on-site at set times.
16. Ensure employees trust and help each other to provide an environment that motivates people.
17. Avoid long and detailed reports, and encourage minimizing documentation when possible.
18. Project teams should work on-site at the appropriate project rooms reserved for the project. In the project rooms, important project documentation should permanently be displayed.
19. Implement open workplaces to encourage collaboration.

Table 53: Agile principles for the construction industry

A total of nineteen principles have been established in order to apply the agile project management methodology in infrastructure projects. The original agile principles applicable to the ICT industry, as provided on page 17, display a total of twelve principles. All of these principles portray similarities with the principles established for the construction industry. However, some of the principles have been altered to suit infrastructure projects. Additionally, in the principles as displayed above, five principles are not stated in a similar manner in the original

principles. These five principles are related to cross-functional teams, spreading information on time and to the entire project team, minimizing documentation, establishing proper project rooms that allow project teams to work on-site, and lastly establish open workplaces. Nonetheless the content of the principles has been mentioned in the literature review. Hence, the list of principles above are complementary to the ICT principles as originally stated and provide project managers with the fundamentals of how to implement the agile project management methodology in the construction industry.

CHAPTER 6
Expert Panel

6. Expert Panel

In this chapter, the conceptual model as developed in the previous chapter was validated through an expert panel session. The applicability of the model as well as adjustments that were made to the model shall be discussed. Firstly the conceptual model will be explained, followed by an illustration of the experts involved in the session, the results from the discussions during the session, and the validation of the statistical data analysis.

6.1 Conceptual Model Added Value

The section regarding developing the model (Section 5.4) in the previous chapter explains the added value of implementing agile, along with areas of attention when implementing agile. Additionally, the pre-conditions in the form of principles were established that provide project managers with an insight of the fundamental of agile project management in the construction industry during early project phases. In order to establish how a project manager will be able to apply these results in practice, a model was established that elucidates the steps a project manager should follow in order to develop added value in early project phases of infrastructure projects by adopting agile project management. The conceptual model was presented to the expert panel during the validation session.

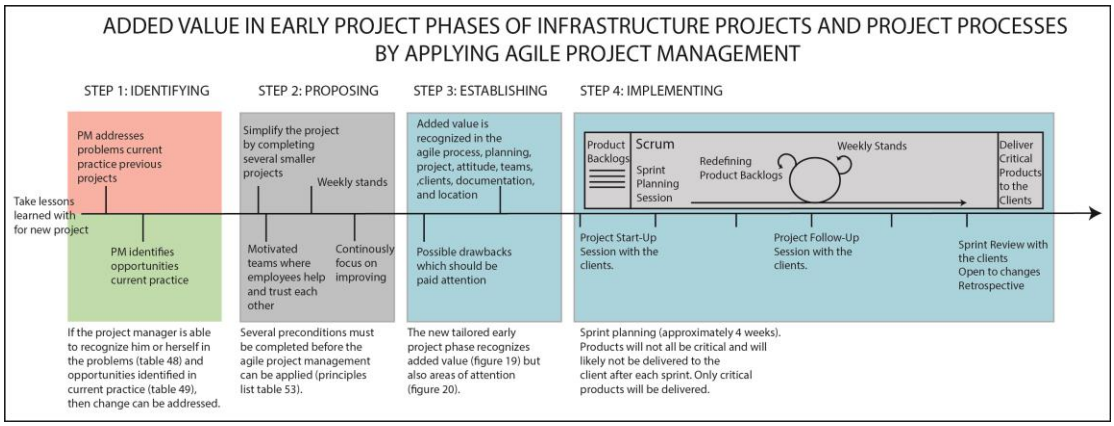


Figure 18: Conceptual model added value agile project management

Before discussing the conceptual model with the experts, the researcher explained to them the contents of the model. As the figure illustrates, the model has been divided up into four steps, namely: identifying, proposing, establishing and implementing. Each step will need to be completed in order to implement agile project management in the construction industry and achieve added value. The process starts with the project manager taking lessons learnt from previous projects along to the new project. Then, the first step requires the project manager to identify the problems of current project management as recognized by the respondents, as well as the opportunities in current project management. This step is followed by proposing the implementation of agile project management through the preconditions as established through the literature review and data analysis. The preconditions have been provided in the form of principles that provide the fundamental of the agile project management methodology for the construction industry. The next step is the third, where added value is established through the new tailored early project phase. Next to these added values established, additional areas of attention will also be provided for implementing the methodology in the construction industry. The fourth step in the model entails the implementation of the methodology. Thereby explaining that the project should start with a project start up sessions which involves the client, where the product backlogs are established. Following will be the sprint planning. The four week duration sprints will consists of weekly stand-ups and redefining the product backlog. After approximately 2 weeks, the project follow-up sessions should be established which also involves the client. Furthermore, at the end of the sprint, a review session should be organized whereby the project team is open to changes and allows these, unlike during the phases. During the phases changes should not be processed. During the sprint, specialists should be able to perform their work without constantly getting interrupted. For this reason, the clients are advised to only be involved at set times. Finally, the sprint completes by delivering critical products to the clients. This has been mentioned as not all products will always be necessary to deliver to the clients. It

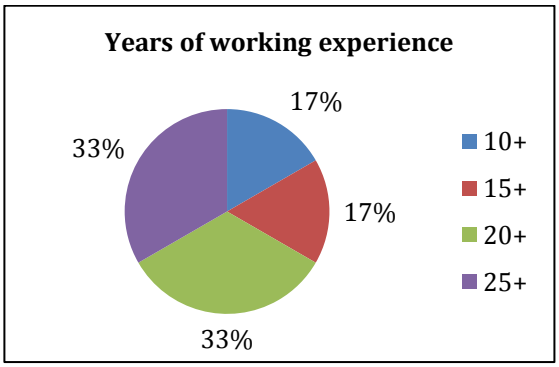
can also be an internal product that will be delivered to the project team. As commonly the early project phase takes many months, the sprints will be repeated several times.

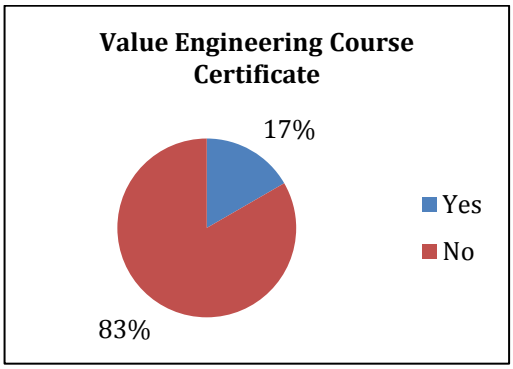
6.2 Set-up Expert Validation Session

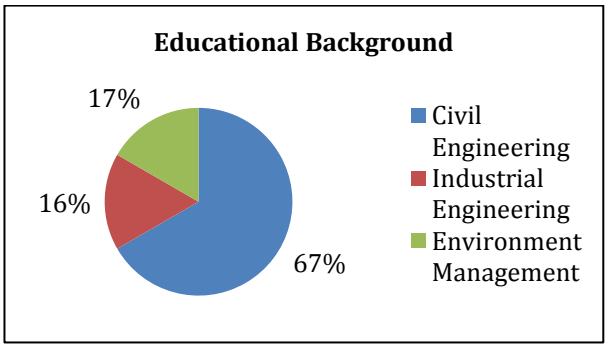
The purpose of the expert validation sessions was to receive feedback from the experts in discussion form regarding the conceptual model. Prior to the expert validation sessions, the experts were provided with the presentation regarding the results, which also displayed the model. The expert validation session was organized with six respondents and took approximately one hour. During the first ten minutes of the session, the presentation as sent prior to the session was presented. Following the presentation, the respondents were requested to individually fill in a survey and answer the questions up for discussion as well as ranking whether they agreed with the identified added values and proposed areas of attention (see appendix E1 for the survey). The survey took approximately ten minutes and was followed by a group discussion where each of the open questions were discussed.

6.3 Expert Characteristics

In order to provide reliable results, the researcher limited the experts to included employees within a minimum of ten years of working experience as a project manager for infrastructure projects. In total six experts were able to attend the validation session. In the survey they filled out prior to the group discussion, the experts were asked to enter some information about their backgrounds. The charts below identify the years of working experience of all experts, whether they completed a value engineering course, and their educational background. Whether they have completed a project management course has not been included, as all experts have completed this.







As the first chart shows, regarding years of working experience, more than half of the experts had more than twenty years of experience. Only one expert had between ten to fifteen years of experience. Likewise only one expert had between fifteen and twenty years of experience. The second chart, regarding value engineering course certificates, shows that only one expert completed a value engineering course. This could indicate that the experts were not quite aware of value management in their projects and this was new to them. The third chart pinpoints the educational background of the experts. Most of the experts completed a master's degree in civil engineering.

6.4 Discussion Open Questions

The discussion of the open questions is been based on the group discussion as well as the answers provided individually by the experts prior to the discussion. The answers to all of the open questions will confirm whether the proposed conceptual model will be sufficient for current practices or whether it should be adjusted in order to be applicable. Additionally, the company's culture will be discussed in order to establish whether this model will also specifically be applicable to the company.

Do you think the model is applicable for infrastructure projects?

In general all respondents replied that the model is applicable for infrastructure projects. Regarding some of the proposed activities such as for example encouraging a good collaboration and communication is definitely very important for complex infrastructure projects where the scope changes and isn't clear all the way from the beginning. Another respondent stated that the sprints will be very useful for projects instead of the very structured beginning until the end approach currently mostly adopted. The third and fourth respondent added that in essence the model will be applicable in terms of the activities and steps stated, however the structure of the model will also need to be accepted by the project team (including the clients). Another respondent stated that a lot of the activities as stated in the preconditions and implementation of agile project management are already often being implemented to a certain extent. Therefore, the model will be applicable to infrastructure projects as now there are steps to follow and there is an example of how to structure the process of implementing these activities.

In terms of type of projects for which the model will be applicable, a discussion arose as the respondents agreed that the model would not be as applicable for small projects. This refers back to one of the first remarks from one of the respondents during the discussion on the model. The respondent mentioned that the situation of the project can sometimes be that the team delivers as requested upon. This is mostly the case for the smaller projects. During the discussion, the respondents agreed that the model is applicable to larger complex projects where the scope cannot clearly be determined upfront. Implying that the early project phase of the project is therefore also of considerable length (at least more than 6 months).

Which elements of the model are currently unclear?

Two of the respondents stated that the model was clear for them and they could not specify unclear elements. The second respondent stated that it was unclear whether the model was only for larger complex projects or also for small infrastructure projects. As in the respondents opinion, if the model would also be applicable to smaller projects, it was unclear what the difference would be for applying it. In the respondents opinion the model is more related to large complex projects only. Furthermore another respondent stated that the preconditions were a bit unclear, as the respondent was wondering if it would also be possible to only apply certain principles in order to retain added value? Or whether firstly all of the preconditions should be met in order to achieve added value through agile project management. Another respondent stated that it was unclear for implementing agile project management how the four week sprints can be translated to infrastructure projects, as the early project phase for infrastructure projects takes up more time. Lastly another respondent replied that next to the translation, in order for the model to be applicable in practice, simpler terms in which the company is already familiar should be used. For example for sprints the company uses design loops. However, this would not be a precondition for the model to be applicable in the construction industry, it would simply make it more clear for employees who have not yet heard of agile project management. Another option would be to add the model to the project management courses provided by the company, in order to make everyone aware of the model and specific agile project management terms.

Moreover, in the implementation phase of the model, a discussion arose between the implementation differences for the client and internal. The bottom part of the model seemed to be focused on interaction with the client, and the top part of the model for internal implementation. Several respondents mentioned to prefer a clearer way to implement the methodology for both parties, thereby splitting the implementation phase up into two parts: implementing added value to the client and implementing added value to the project teams internally.

What should change in order to make the model more applicable to the construction industry?
In general the respondents replied that mostly the model was clear and will also be applicable to infrastructure projects, especially as some employees are already aware of certain activities and will now be provided with a way to structure these activities and implement them according to the agile methodology. One of the respondents stated that the model implies that there is a fast reaction from the client. However, in practice, the client will need decision time between sprints. Therefore, some more room in-between the sprints should be provided to make the model more applicable. Another respondent added that the target project should be provided upfront as a precondition for implementing the model. More information should be provided on the type of project, length of the project and maximum team size in order to really be able to apply the model. Therefore, a different set of preconditions. Another change that could make the model more applicable, as stated by two of the respondents, is another step in the beginning of the model identifying the evaluation activity of the tender. This then leads to identifying which problems and opportunities could be applicable to the project and also the other steps.

Do you agree with added value through agile project management?
Coherently all respondents agreed to the added value of the methodology as illustrated in the model. Two respondents stated that especially in terms of evaluating after each sprint and thereby receiving more frequent and timely feedback from the clients and being able to adapt changes on time. Another two respondent added that often the projects with a long time span become less structured, which can result in chaos. By implementing these short sprints, more overview will be provided for the clients as well as the project team. Overall the respondents stated that the structure in repeating the activities in terms of sprints and evaluations throughout the process will be necessary to also experience the added value. Therefore, upfront the project manager will need to decide whether the project can live up to the preconditions for implementing the methodology as well as fulfill the project type requirements. Once the project manager will be convinced, the client will also need to be on board for the added value to also be delivered throughout the project.
Another added value that the respondents agreed on to be very important is the interim client and stakeholder satisfaction which is currently often not completed. This will allow for the project and the project team to continuously be able to improve. This will be of added value both internally as well as for the client.

Do you think the culture at W+B is suitable to apply this model?
In general the respondents agreed that the company is suitable to apply the model. Nonetheless the respondents agreed that the budget for projects and attitude of the project team member will be the biggest concern and reason why the model might not be applicable at all times. All respondents stated that the acceptance of the model will be different per employee as the attitude of people is different for everyone and might be resistant. For example, the model implies a lot of travelling in order to always work on-site, which might not be convenient for all employees. Additionally, budget will need to be available for the model to be implemented, as the travels, project rooms, and meetings all cost a considerable amount. Nonetheless, the advantage of working together on-site is increasingly recognized as an opportunity by employees, making the model suitable.

What are the pre-conditions for you to apply this model in practice?
Several preconditions were collected during the discussion on the applicability of the model in current practice. Several respondents stated that they would like to know what the role of the clients will be, a more clear description of when exactly they are to be involved, and what the project team will need to communicate in order for the clients to recognize and be convinced of the added value. Additionally, employees will need to be committed to travelling and working on-site, indicating that there more be enough availability of sufficient project rooms. Another precondition stated by one of the respondents is that the project teams should be more clearly defined (roles, maximum size). Moreover, two other respondents stated that it should be made clear that this model is only applicable for larger projects and when all team members work on-site. This will allow for more interfaces between employees right from the start of the project. Lastly, the respondents agreed in their discussion that once this methodology is to be chosen, the entire project team should also continue to apply this methodology throughout the early project phase, not only for one particular product.

6.5 Expert Discussion Added Value (yes/no questions)

In the survey, the experts were individually asked to validate the nineteen added value statements as found from the survey data analysis. During the group discussion the experts discussed the values in and revealed which values they agreed upon to deliver added value.

# Added Value	Expert					
	1	2	3	4	5	6
1	√	√	√	√	√	√
2	√	√	-	√	√	-
3	√	√	√	-	√	√
4	√	√	-	√	√	√
5	√	√	√	√	√	√
6	√	√	√	√	√	√
7	√	√	-	√	√	√
8	√	√	√	√	√	√
9	√	√	√	√	√	√
10	√	√	√	√	√	√
11	√	√	√	√	√	√
12	√	√	√	√	√	√
13	-	-	√	-	√	-
14	-	-	√	√	-	√
15	-	-	√	-	-	√
16	√	√	√	√	√	√
17	√	√	√	√	√	√
18	√	-	√	√	√	√
19	-	√	√	√	√	√

Table 54: Added value statements expert validation

As the table indicates, ten out of the nineteen added value agile elements were recognized by all experts. Another seven added value elements was recognized by a minimum of fifty percent of the experts. Only two of the added values were only recognized by one or two of the experts. None of the added values was recognized by none of the experts.

# of experts validated	Level of Ranking
6	High
3-5	Medium
1-2	Low
0	None

In order to identify which of the added values are most important, the expert opinions will be ranked and compared with the ranking based on the correlation analysis. As the table in Appendix E1 shows, eight of the added value statements for agile project management were recognized with the same ranking in both the correlation analysis as the expert validation ranking.

Validated Added Value Agile Project Management

The ranking as of the added value statements of agile project management will be concluded in the following section. The table below will display all of the nineteen added value statements as developed in the results analysis chapter and will rank the statements according to the expert validations.

As the figure illustrates, ten of the added values are mostly recognized as added value through implementing agile project management. These agile elements relate to the agile themes of process, project, attitude, location, teams, and clients.

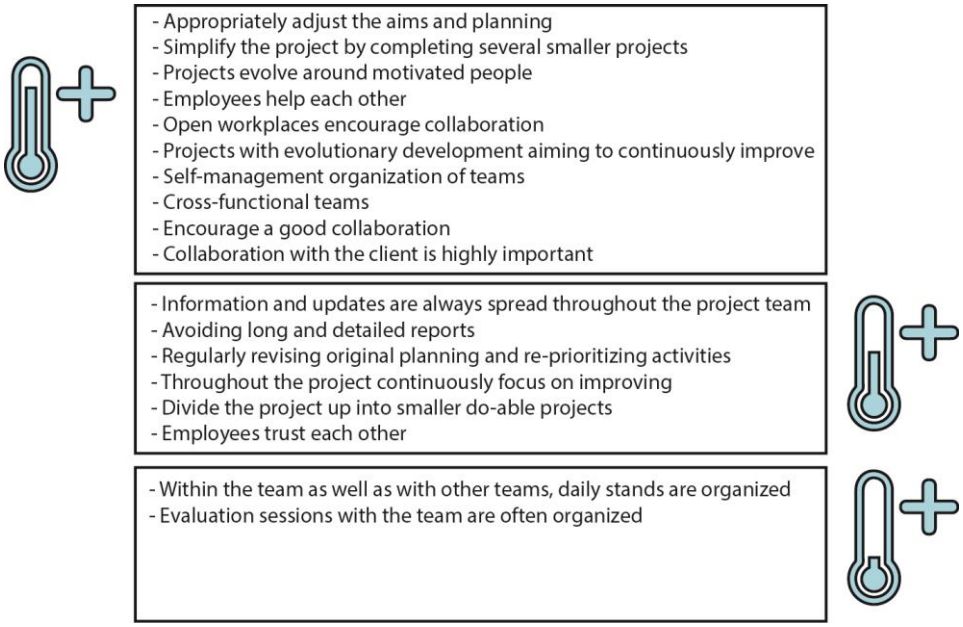


Figure 19: Validated added value of agile elements

The agile elements that were not recognized coherently cannot be stated as added values for agile project management with full certainty. Moreover, some of the agile elements not recognized by all of the experts could also possibly be project or person dependent.

6.6 Expert Discussion Areas of Attention (yes/no questions)

Likewise, in the survey the experts were individually asked to validate the ten areas of attention statements as found from the survey data analysis. During the group discussion the experts discussed the values and revealed which areas of attention they agreed upon.

# Attention	Expert					
	1	2	3	4	5	6
1	√	√	√	√	√	√
2	√	√	√	√	√	√
3	√	√	√	√	√	√
4	√	-	√	√	√	-
5	√	√	√	-	-	√
6	√	√	√	-	√	-
7	√	√	√	-	-	√
8	√	√	√	-	-	√
9	-	-	-	√	√	-
10	-	-	-	-	-	-

Table 55: Areas of attention expert validation

In order to appropriately act on the areas of attention, the expert validation will be ranked. This will provide an indication of which agile elements are coherently an area of attention recognized by all experts as well as which element has not been recognized as an area of attention by any of the experts.

# of experts validated	Level of Ranking
6	High
3-5	Medium
1-2	Low
0	None

Likewise, the ranking of the agile elements considered as areas of attention will be ranked in the same manner as the added value elements of agile project management. The full table is shown in Appendix E1.

As the table below illustrates, three of the agile elements were considered to be an area of attention by all of the experts, and should therefore be carefully taken into account in the model. Another five agile elements were considered to be an area of attention by a minimum of half of the experts. One of the agile elements was considered to be an area of attention by one or two of the experts. Moreover, one of the agile elements that had no significant of highly significant correlation result from the survey analysis was not considered to be an area of attention by any of the experts. It will therefore be taken out of the final validated list of area of attention. During the discussions of the surveys as part of the case study interviews, respondents mentioned to be unaware of color-coding. This could be an explanation as to why the agile elements showed no significant correlation in the analysis and why it is also not an area of attention.

Validated Areas of Attention

The ranking of the areas of attention of agile project management is concluded in the figure below. A total of nine areas of attention are provided, with three that were recognized coherently during the expert session.

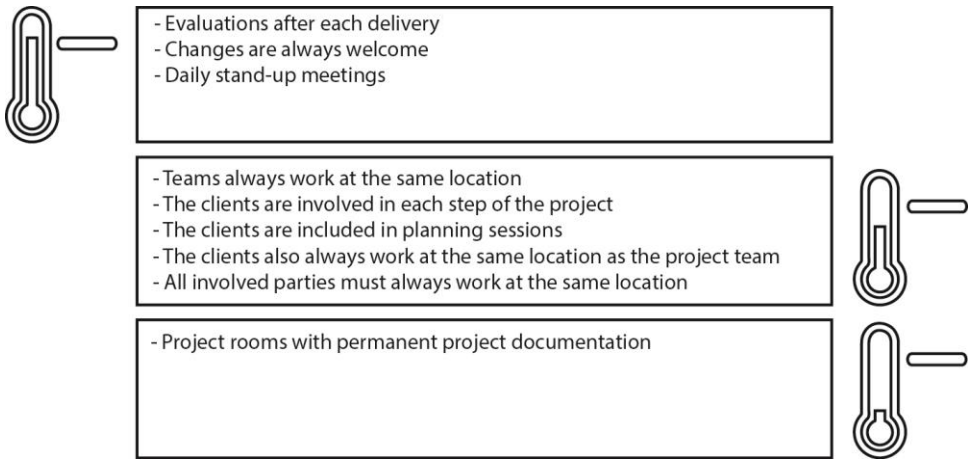


Figure 20: Validates areas of attention agile project management

The highest areas of attention have already been processed in the conceptual model as weekly stands are implemented instead of daily stands. Additionally changes are only welcome in-between sprints and at the set times during the sprint. Therefore, the specialists will be able to perform their work without constantly being interrupted. Evaluations after each crucial delivery should be incorporated in the final model. The additional medium areas of attention regarding including the clients and working on-site should also be incorporated in the model as only at set times working on location as well as including the client at set times. The project rooms are only an area of attention as they often do not fulfill the demands and do not allow all team members to work together at one location. Therefore, the type of project rooms should be improved.

Conclusion

The expert validation was able to evaluate the conceptual model and discuss the manner in which the model is applicable to the construction industry as well as elements that should be added or eliminated from the current model. In addition to the model, the established added value and areas of attention were also validated by the experts during the group discussion.

Overall, the experts agreed that the model is applicable to infrastructure projects. Nonetheless, the model should state in a more clear manner for which particular infrastructure project it will be applicable. The experts agreed that the model will be applicable to longer large complex infrastructure projects when the scope is not definite at the start. This should be indicated in a clearer manner to the project manager implementing the model. Additionally, at the start of the model, there should be a step that evaluates the tender in order for the project manager to then be identify the opportunities and problems. Moreover, the sprint is now only provided once. As the sprints will need to be repeated several times, this should be illustrated more clearly in the model. Also, there should be room in-between the sprints for the clients to have decision time. Moreover, the experts stated to want to have a clear distinction between the role of the internal project team during the sprint process as well as the client's involvement.

The general conclusion by the experts was that some of the activities as stated in the preconditions are currently already being applied, however in a slightly different way and not using the agile project management methodology terminology. Additionally the activities are only used sporadically and the respondents agreed that it is often unclear to employees how these activities could be incorporated in the project regularly. Overall, the establishment of the model in their opinion was of added value to infrastructure projects as it provides project managers with a clear overview of how to implement activities that amongst other things improve collaboration and flexibility in processes.

CHAPTER 7
Discussion, Conclusions, and Recommendations

7. Discussion, Conclusions, and Recommendations

This last chapter shall firstly discusses the research results and present the validated model for added value of agile project management as well as identify the limitations of the research. Following, the research objective will be satisfied by answering the research sub- and main question. Furthermore, this chapter will also present recommendations for Witteveen+Bos and also for future research.

7.1 Discussion

The discussion section shall reflect on the research findings and present the limitations of the research. The research findings will be reflected upon through the discussion of the steps followed in order to answer the research objective. In the conclusion of the chapter, the validated model of added value of agile project management will be provided. Finally, a discussion of the limitations of the research will be provided in order to acknowledge the effects of possible influences in the research.

7.1.1 Research Findings

As discussed upfront during the introduction of the research, conventional project management takes on a more unwelcoming manner towards changes during projects which has caused well-known overruns in the past. Moreover due to the increasing complexity of projects, particular aspects in conventional project management environment have become unsatisfactory. Hence often insufficient value is delivered to stakeholders.
The objective of this research was to develop a model for agile project management applicable to the construction industry. The model will present added value in terms of project and process. The agile project management methodology anticipated added value in the ICT industry, which developed the starting point of this graduation research. Could this methodology also add value in projects and processes in the construction industry? And how?

Hence the aim of the research is to provide an answer to the main research question, being: *what is the added value of agile project management during early project phases in the construction industry?* The starting point of the graduation thesis research was researching upon the implementation of agile project management in the construction industry. The scope of the graduation research was limited to early project phases of infrastructure projects.
Firstly the current obstacles in conventional project management infrastructure projects was researched, followed by an extensive literature review on agile elements applicable to the construction industry as well as value management in terms of projects and project processes. As both aspects of the research are relatively limited in scientific literature for the construction industry, an extensive literature study was essential. The literature study formed the foundation for the research performed in the following phase of the graduation research.
The outcome of the literature review presented agile elements and value measurement criteria for both projects and project processes. Next to the literature review, exploratory interviews were conducted in order to explore current practice of project management and value management as well as be able to compare these outcomes to the literature review to identify possible gaps. The outcomes of the exploratory interviews illustrated the unawareness of agile project management in current practices of infrastructure projects, which confirmed the literature review. Additionally an unawareness of value management and ways to measure value in projects and processes was derived from the exploratory interviews, which was different from what literature stated. Although literature stated value measures, especially in terms of value of process in the construction industry – lack of literature was available. Moreover, the outcomes of the arrangements of early project phases in the construction industry were similar to the outcomes collected from the literature review. The exploratory interviews specified the activities for the construction industry, which was comprehensively mentioned in literature.

For the following stage of the research, a case study analysis was completed for five different infrastructure projects. For each case study, four to five employees were interviewed. The respondents were interviewed regarding problems and opportunities in current project management as well as value management measures. Through a cross-case analysis the outcomes of the different cases were compared and final outcome of value management, and problems and opportunities in project management for current practices was established. Next

to the case studies, the research methodology was focused on analyzing the current use of agile elements as well as value measures. This was completed through survey data gathering. In order to perceive a reliable result a minimum of sixty surveys were to be collected. All of the employees filling in the survey had to provide information regarding an infrastructure project in early project phase. The data gathered was then analyzed through a correlation analysis in order to identify significant and highly significant relations that enlightened value of agile elements in current practice.

By comparing the outcomes of the two different research methodologies, a final conclusion was established for what would complement current practices needed in order to minimize current obstacles and anticipate the opportunities. The final conclusion portrays how this could be completed through implementing agile elements that are already considered to be valuable in the construction industry. This analysis developed the conceptual model of added value of agile project management in the construction industry. As the literature study and exploratory interviews already acknowledged that the area of knowledge researched upon was relatively unknown, the conceptual model had to be validated by experts in order to provide a reliable solution. The solution was provided in the form of a model to clarify the added value attained through agile project management in the construction industry.

Considering the problem statement as formulated in the introduction, the conclusion of this research extends existing knowledge on value and implementation of agile project management in infrastructure projects. Existing knowledge on value management mostly focuses on project value, and less on process value. Also, existing knowledge focuses more on conventional project management in construction, and could be complemented by focusing more on the process value derived from aspects of agile project management. As little knowledge is available on agile project management in construction as well as the value of the methodology for the construction industry, this research is able to extend existing knowledge in this field. Nonetheless, it is noteworthy to acknowledge that the extension of the existing knowledge is limited as the client's perspective was not included.

7.1.2 Limitations of the Research

In this section the limitations of the research will be discussed. As two types of limitations were endured, the section will also be split up into two streams. Firstly the limitations for the literature review will be stated, followed by the limitations of the research.

Limitations of the literature review:

- The review on the agile elements also applicable to construction is limited due to the limited amount of literature available for agile project management in the construction industry.
- The value management criteria are limited due to time limitations and literature. If a more extensive review was conducted with more literature, the criteria list could become more complete and reliable.
- The value management literature in projects and processes is limited due to the amount of literature available that is also applicable to the construction industry. The limited literature also applicable on value measures used for agile project management.

Limitations of the research:

- Different employees from companies were asked for interviews and to fill in the survey, however as not the same amount of employees were applied for the data collection, a comparison between companies was not possible. The research could therefore be influenced by the graduation company's culture and might have a different outcome if the research was also completed at a different company. Additionally, the research could also have a different outcome if it was only performed at the graduation company.
- The agile elements included in the survey were based on assumptions from the literature study based on the characteristics, values and methods of agile as applied in the ICT industry. This makes the internal validity of the research limited, as maybe other agile elements were missed due to the length of the literature review.
- The respondents in the survey and case study can have different personalities and influence the outcome of the research. As the research requested a project director or

project manager to assist with possible respondents to approach, the choice of respondents could potentially be bias.
- As the majority of the respondents for the case studies and survey were unfamiliar with agile project management, their response could be less reliable. As the opinions and results of this research are mostly based on people who are unfamiliar with agile project management in practice, the outcome of the research is less reliable. The same goes for the expert validation. As due to time constraints it wasn't possible to arrange an expert panel with agile experts, experts in project management were used.
- For some of the case studies, the same employees were engaged in the project. This meant that a choice had to be made for which project to interview a particular employee. Therefore for the project for which the employee was not chosen, another employee had to be selected. This meant that sometimes another project role was selected instead of the desired project role within the core project team.
- The research was limited to the project team only and did not involve the clients. Thereby the results as presented in the model are limited.
- Another limit of this research is the amount of respondents and number of case studies. Possibly, the outcomes of the research could have been different if more case studies were explored as well as more respondents interviewed.

7.2 Conclusions

In this section the overall conclusion of the sub-research questions as well as the main research question will be provided. Thereby the overall objective of this research will be answered, providing a model applicable in the construction industry presenting added value measurement of agile project management.

What is agile project management? And what are the differences with conventional project management styles?

The agile project management methodology, originating from the ICT industry is defined in section 2.3 through ICT literature as: *an iterative process that is able to continuously improve deliverables through increased collaboration and flexibility ensuing increased customer value in projects*. The management approach focuses amongst other things on client involvement, adaptability of projects through an iterative process, and team interactions. Table 7 provides a summarized overview of all of the characteristics and activities belonging to the agile project management methodology. Generally, through early and frequent deliveries as well as regular feedback, the focus of value generation is adopted in the earliest phase of projects. Thereby establishing value from an early project phase onwards in an evolutionary manner.

In the literature review, research was completed on the current twelve ICT agile principles, the four agile values, agile project characteristics and activities, and seven agile methods. The problems and reasoning for implementing agile in the ICT have overlap with the issues experienced in conventional project management. The full list is provided on page 14, and describes among others that low customer involvement; unrealistic expectations and lack of planning were experienced in ICT project environments prior to the adoption of agile project management.

Moreover the review of literature also provided an overview of the differences between conventional and agile project management methodology. Table 12 states all the differences recognized in literature. Overall, differences between the two methodologies can be established through clients, documentation, scope, location, process, teams, and communication. APM focuses more on client involvement, considers the interactions highly important, and includes the clients at all times during the project. Generally CPM is more reserved and prefers to keep a certain distance from the clients in their project environments in order for specialists to be able to complete their work. Documentation approaches are different in the two project management methodologies as CPM usually delivers extensive and detailed reports often, whilst APM focuses more on minimized documentation. To a certain extent the detailed reports must remain as certain construction regulations and for legal purposes details have to be provided in certain documents in the construction industry. Nonetheless, often for example project management plans are established for the entire length of a project. Thereby including information that it likely to change in the near future, and result in reworks. Instead plan per project phase should be established. For scope, this is often established upfront in construction projects whilst for

APM this is developed incrementally. For location, in CPM employees are generally spread and work at their own offices, whilst for APM employees are requested to work on-site at the allocated project rooms. Additionally the process approach is different for both methodologies. For CPM the process is generally more linear with a predefined start and ending of a project, whilst for APM the process is iterative allowing an evolutionary development. Moreover, teams are also generally different for CPM and APM. The CPM methodology generally has larger teams with a specific role separation whilst APM considers cross-functional smaller teams to be more useful with a self-management attitude. Lastly, communication is different in both approaches. In CPM this is often more formal and distant (also in the form of emails and skype), whilst for APM focuses on face-to-face communication and always encourages frequent and openness of information exchange.

Overall as the two methodologies focus on different aspects of value in project management, it could be possible for the methodologies to complement each other. As the research analysis has revealed, particular aspects of conventional project management have established obstacles for current complex projects that are generally found in the project processes. Hence as the value of agile project management focuses more on process value delivery, the methodology could assist current practices in minimizing currently experienced obstacles.

How can value in projects be measured?
Value management was defined in terms of value for a project and value for a process. The two types of values are interrelated but are measured in a different manner. The definition established for the value of projects in literature is: *value directed towards the delivery of a product or a service to clients and stakeholders at an optimum quality and performance as well as at an acceptable cost and schedule*.
In order to measure value for projects, criteria had to be established. As literature has states, measuring value of a project is often simply discussed and therefore implicitly measured instead of explicitly. This was also the outcome of the exploratory interviews.

Nonetheless, literature was researched upon in order to establish criteria that measure the value of projects. The literature review stated that value in projects is discussed in terms of how the project performed. Thereby measuring the benefits of performance of a project as their value. Hence, performance value criteria were selected in order to measure the value of projects. Through literary research and cross-referencing results five main criteria were selected to measure, namely: costs of a project, time of a project, scope of a project, quality of a project, and clients and stakeholder satisfaction of a project.

Each of these project value criteria were again analyzed in order to establish methods and tools for each criteria. The final list of the methods and tools can be found in table 17. Through the cross-case analysis the results showed that in current practices of project management costs (by applying the forecasting method) and quality (by applying the methods: plan & define requirements achieved, and evaluations) are mainly measured. Nonetheless the value measures for projects of agile project management concluded that value is considered in terms of scope of a project and clients and stakeholder satisfaction of a project.

Acknowledging this gap in literature, as current practice measures are different than the results of value measures for projects from literature, a new definition should be formulated. As there was no universal value measurement definition for projects, in the literature study a combination of different definitions was applied. After completing the research, a new definition can be provided that combines the knowledge from agile literature with current practice for the construction industry.

Value for agile infrastructure projects is directed towards focusing on continuously improving and frequent deliveries of products to clients and stakeholders, thereby timely satisfying the project scope.

The definition for value of projects as established upfront in the literature review focused more on completed the project aim within time and cost, whilst the value of projects for agile in the construction industry focuses more on frequently delivering and timely feedback from the clients that allow the project team to continuously improve and satisfy the project scope.

Moreover evaluating the measures as established in literature, time of a project was not acknowledged as a consequent project value measure in any of the research methodologies. Nonetheless respondents mentioned time measures to be important to define the value of a project. However, this is done in a more implicit manner. All in all the results of the research show that agile project management is an input for value management for projects, however the focus of the methodologies is more on process aspects which lead to the final project. Hence anticipating that projects and processes are interrelated to a certain extent.

How can value in project management processes be measured?
As previously stated, value management was defined in terms of value for a project and value for a process. The two types of values are interrelated but are measures in a different manner. The definition established for the value of project processes in literature is: *the integration and satisfaction of the completion of activities from the concept to completion of a project using the appropriate tools that meets the client's needs*. Likewise, the performance of a process was taken into account as a starting point for measuring the value of the process.

Through a literature review and cross-referencing the different results, twelve criteria were established for project processes. Some of these criteria are similar to the project value measures, but have still been taken into account as the criteria have a different aim. For example the cost of a project is repeated as budgeting. However, for project value this relates more to the final completion sum whilst budgeting refers to dealing with changes in budget and regularly revising the budget consumed throughout the process. All-in-all the following twelve criteria for measuring value in project processes were established: scheduling, interim clients and stakeholder satisfaction, project teams, budgeting, performance information, resources, scope adjustments, communication, risk management, quality, individual attitudes, and managing changes.

For each of the criteria, research was completed on the methods and tools available to quantify the criteria. Through the cross-case analysis the results showed that in current practice scheduling (by applying the methods: lean planning, milestones; tools: Gantt chart and critical path method), budgeting (by applying the tool: planned and actual costs in excel) are mainly measured. The case studies and survey results revealed that currently more attention is paid to measuring project value instead of the project process. However, respondents agreed to want to measure more for the process value in the future, such as: interim clients and stakeholder satisfaction and risks management if they were provided with appropriate methods to do so. Moreover, the respondents agreed on an increased interest in measuring the value of project processes, configuring the results of agile project management as the results show that the methodology is more focused on process value. Hence value measures for processes of agile project management concluded that value is considered in terms of interim clients and stakeholder satisfaction, teamwork, performance, resources, scope, communication, attitudes, and change management for processes.

Acknowledging this gap in literature, as current practice measures are different than the results of value measures for processes from literature, a new definition should be formulated. As there was no universal value measurement definition for processes, in the literature study a combination of different definitions was applied. After completing the research, a new definition could be provided that combines the agile knowledge from literature with current practice for the construction industry.

Value for agile infrastructure processes is focused on teamwork and being able to continuously improve required deliverables throughout the project development. This is completed by adopting the correct attitude (ensuring employees trust and help each other) and by encouraging a good collaboration with clients and stakeholders.

The definition as established upfront in the literature review focuses on all of the activities between the beginning and end of a project and measures scheduling and budgeting. The agile project management methodology for processes focuses more on the soft skills in processes to deliver value.

In current practice, respondents have stated that project process value is related to the way you get to your results whilst project value is more result-driven. Moreover in terms of measures, quality is the only measure for processes not recognized in any of the research results. As quality is included in the project value, the results imply that quality should only be measured for project value. As the respondents have universally stated to find it valuable to focus more on the measurements of process value and agile project management encourages this approach, a conclusion can be drawn. The necessities of current project management can be anticipated by implementing agile project management as this improves the value of project processes and encourages process measures. Thereby agile project management is an input for value management for project processes, especially as value is often implicitly measured and controlled. By applying the principles agile project management in the construction industry, the value of processes can become more explicit. Hence complementing obstacles currently considered in communication and interfaces for project processes.

Which aspects in project processes are currently not delivering optimal value?
The general aspects in project processes that are currently not delivering optimal value were based on the drawbacks of value delivery as stated in the case studies as well as the problems endured in current practice. During the cross-case analysis the separate drawbacks in delivering value were compared. This resulted in six relevant drawbacks being: high time pressures often make it difficult to deliver adequate quality of products, management of expectations from the clients, not all employees are trained and know how to apply particular project management methodologies as suggested during the project, lack of proactive interference in decisions made by the clients, fear of negative judgment, difficulty in determining maximum value in projects as work is often parallel to each other due to time pressures

These drawbacks in value delivery suggest a lack of involvement of the clients (interfaces), proper communication, and the correct attitudes. The high time pressures can be due to many reworks or lack of proper communication and awareness of the requirements and expected quality of the clients. By providing interim feedback from the clients and delivering critical products frequently, this drawback can be overcome. Moreover, by inviting the client to join at set times, the clients will feel more included and will be able to intervene on time, if necessary. Negative judgment mostly has to do with attitudes. If the project environment does not encourage an open collaboration where employees help and trust each other, this fear can be developed. Moreover, the fear can also be related back to the involvement of the client. If this is not completed frequently, the project team might be less aware of the expectations and requirements of the client and fear develop a fear for negative judgment, as their interpretation of the scope might be different. For determining the maximum value in projects, proper communication is essential. Especially as in the construction industry employees often have several projects they are working on at the same time, it will be necessary to continuously make employees aware of the bigger picture of the project. This is completed through regular face-to-face meetings and weekly stands that re-prioritize activities and discuss the progress of the project.

Additionally, several project management problems were identified in the case studies. These problems were also based on the case studies and encounter the drawbacks as established previously. Nine problems in current practice were established by the respondents.

1. Difficulties in finding the right people for the project.
2. Often not enough time is spent together on location.
3. Often the project team is not provided with proper documents.
4. Miscommunications, misinterpretations, and confusions are often caused by different language use within projects.
5. Schedules are often tight, making it almost impossible to follow it accordingly if changes occur.
6. The client is often more than one person. This can result in different opinions on deliverables.
7. Sometimes the client's involvement cannot be influenced if the client does not have the time to join team sessions.
8. Specialists often lack skills to communicate their good work appropriately to the client.
9. In case of holidays, scheduling is often too tight and not enough people are available.

These problems have been analyzed in terms of how agile elements are able to minimize these problems and develop additional value. An overview of the analysis can be found in table 49. Likewise, a lot of these problems found the need in a change of attitude, a different approach for teamwork, and simplifying the project into smaller projects. This will allow the clients as well as the project team to develop a more proper overview of the expectations and deliverables.

How can value be optimized in these processes when applying an agile project management methodology, and lead to project value?

The general discussion on value optimization and opportunities formed in current practices, were based on the case study interviews. Through the cross-case analysis all of the individual respondent results were compared to form six main statements regarding opportunities for value delivery, namely: improved methods of communication, spending more time and sessions on the interfaces between important deliverables, take the time to discuss the project value and deliveries accordingly, organizing sessions together with specialists and the clients and managers directed to discuss either team problems, communicative problems or content questions, focusing more on management of the project process in terms of teamwork and communication.

As the last statement already mentions, all of the value opportunities are generally related to improved teamwork and communication. As agile project management greatly focuses on these two aspects, the methodology implies that it could optimize value for projects. Moreover, the respondents were asked to identify opportunities in current project management. Through the cross-case analysis, a total of eight opportunity statements were established.

1. Hire a team coach who focuses on training employees in more coherent communication, teamwork, and the correct attitudes within teams.
2. Make sure enough time is dedicated to getting to know each other.
3. Spend more time on continuously organizing sessions to update all team members
4. Establish periodic audits also at team level
5. Make people aware of their responsibilities also for the bigger picture
6. Establish shorter design cycles and sub-deliveries to enable more feedback throughout the project
7. Take more time to determine the project requirements and expectations together
8. Organize sessions with the client to be able to discuss and check the requirements upfront as well as throughout the project

These opportunities have been analyzed in terms of how agile elements are able to encourage these opportunities and develop additional value. An overview of the analysis can be found in table 48. As the respondents stated, optimized value is achieved through adequate focus on the project process and adding value through exceeding the client's expectations. Overall most of the opportunities in value optimization was discovered in terms of improved teamwork, attitudes, planning, and a different shorter process that encourages frequent feedback and deliveries. As the opportunities show, a lot of the opportunities are considered to be part of how the project teams and clients communicate. Opportunities for optimization are found in focusing more on getting to know each other, making sure people are aware of the expectations, discussing the progress often, and continuously rechecking if the correct activities are completed and suitable products are being delivered.

What is the value when applying agile project management?

In the literature study measures for project and process values were established. For project value five measures were established and for process value twelve measures were established. In the survey analysis through the use of a correlation analysis the value of agile elements was researched upon. The results showed that the value of agile project management focuses mostly on value of a project processes, and thereby initiates being able to complement particular obstacles experienced in conventional project management practices for complex projects.

Overall, a list of values of agile project management is provided in table 43. Generally, the values that were established for agile project management were based on the agile themes in which the agile elements were arranged. Value of agile was found in deliveries, process, teams, projects, attitudes and documentation.

Most of the correlations with the agile element themes were established for process value within agile teams, attitudes and documentation. Thereby insinuating that these facets of the methodology can provide added value for project processes when implementing agile project management. The value within teamwork is found in attitudes and project scope realizations through always encouraging a good collaboration with all involved teams and ensuring all information and updates are spread throughout the teams. Additionally through regularly organizing evaluation sessions allow issues to be resolved actively and incorporate changes in the manner of communication, attitudes, and scope adjustments. Moreover, by implementing a self-management approach for smaller teams that moves away from a long hierarchal organization is able to improve communication and teamwork. Regarding attitudes, less hierarchy can encourage an open attitude and enable more trust and collaboration between employees. This will make the adoption of changes easier. Lastly the value of agile is found in documentation as long and detailed reports for the far future are avoided. Overall, these outputs have presented an input for current project management. Moreover, agile project management has provided an input for value management and value management has provided an input for current project management.

The list of correlations between value and agile project management was used as an input to establish added value. Additionally areas of attention were established, which should be carefully watched when implementing agile project management as they could potentially develop lost value.

7.2.1 Answering main research question

This graduation research explored the added value of implementation of agile project management in the construction industry. The findings of the literature review, exploratory interviews, multiple case studies, surveys, and expert validation contributed to the results for agile project management and value management in construction. The main research question that was answered throughout the research was:

> *What is the added value of agile project management during early project phases in the construction industry?*

This research has presented an analysis of the agile project management as it is known in the ICT industry as well as which elements would are applicable to the construction industry. From the literature review, a total of fifty-five elements were identified as possibilities for agile in the construction industry. These elements were grouped amongst nine different agile themes, being: deliveries, process, planning, teams, projects, clients, attitudes, documentation, and location.

Based on the findings of eighty-seven surveys the value of agile project management in the construction industry was identified. Additionally, the problems and opportunities in current project management as established in five case studies were analyzed. These two inputs for value in project management were compared to the agile elements. Hence, as defined from the case study results added value was defined by exceeding current value. Thus a list of nineteen added values were established, as presented in table 51. These added values were presented to the expert panel, who were able to validate which agile elements would also add value. The outcome as presented in figure 19 provided ten highly relevant, seven medium, and two low added values.

The outcomes that are explained as the most important added value of agile project management are found in six out of the nine agile element themes as established from the literature review, namely: process, project, attitude, location, teams and clients. Other added values that were recognized by several experts were planning and documentation. Regarding these themes added value was established in simplifying the project by breaking it up into smaller do-able projects. This allows you to continuously have a strong focus and be able to deliver frequently and process changes timely. Moreover, added value was established in focusing on planning for the short-term period and revising the planning during weekly stands. This provides employees with awareness of the bigger picture and their responsibilities. Also, interim team evaluations and organizing set times to spread information and updates to the project teams is considered added value. Regarding teams, the aspect of focusing on evolving the project around motivated people that trust and help each other is considered added value. Lastly, minimizing documentation when

applicable was also considered added value. However, this indicates that face-to-face communication methodologies should regularly be implemented to allow this.
Furthermore, added value for clients is found by viewing their collaboration to be highly important and including them in the project process regularly.

The only agile element theme that has not been considered as added value was deliveries. Nonetheless, the concept of receiving more feedback throughout the project process by delivering products to the clients and developing the project in an evolutionary manner is definitely recognized. The biggest concern with the agile elements belonging to the way deliveries should be altered was related to the current design of infrastructure projects where phases take up a much longer period of time. Respondents explained that delivering to the client every four weeks might not always be necessary at all times. However, when they acknowledged that delivering products every four weeks could also be completed by internal deliveries they agreed with the value, and considered it to be complementary to current practice.

Thus, almost all agile element themes are considered to provide added value to current practice especially in the way the project process is organized. In order to illustrate how this added value can be achieved, a conceptual model was established prior to the expert panel (see figure 18). During the expert panel the model was discussed and the experts argued is the model was applicable to infrastructure projects and what should be altered to make the model more applicable. The following section shall elaborate on the validated model.

7.2.2 Validated Model Added Value of Agile Project Management

In order to explain to a project manager how added value can be achieved through agile project management in the early phases of infrastructure projects, a model has been established. The model was altered according to the changes required by the experts in order to make the model more applicable to the construction industry.

Generally, the overall aim of the model was agreed upon by the experts. The experts discussed the agile elements that were advised to be applied to achieve added value. Many of the experts were able to identify themselves in several of the agile elements. However, they all recalled that the agile elements were something that was not focused upon in their previous projects. Instead the elements were mainly applied in case the project team realized that a facet of the project was not running smoothly. Thus the agile elements, in case they were already acknowledged, are applied in a more emergency case manner. Thereby the experts mentioned to be unaware of the added value of agile for the entire process or project, as the methods to implement the elements have not yet been established. Therefore, by presenting the model the experts agreed to have gained a better understanding of how agile can be implemented in infrastructure projects and how the added value of this methodology can be explained in terms of activities towards the clients and the project team.

Moreover, being able to transfer the knowledge of the added value of agile project management was for the experts the most important. As in order to get everyone on board, the project team and clients should be able to identify themselves in the added values. Therefore, this was validated as an appropriate approach of the model. However, before these steps the experts stated to firstly need to establish for which projects this model is actually applicable as well as what the tender description states and if it allows for the agile project management methodology.

Thus, the validated model as provided in figure 21 provided five final steps in order to implement and experience added value of agile project management in the early phases of infrastructure projects. Provided the alternations, the experts universally agreed that the model would be applicable to infrastructure projects.

Figure 21: Validated model added value agile project management

7.3 Recommendations

The limitations of this research make room for further research. As the nature of this research was exploratory, this has left room for a considerable amount of possibilities for further research. Additionally, as the company is not yet familiar with the agile project management approach, also a considerable amount of recommendation for the company will be provided.

Recommendations for Witteveen+Bos

In this section the recommendations for the research company will be provided in order to add value to infrastructure project in early project phases by implementing agile project management. These recommendations will be provided in the following list.

- As the project managers at the company do not have a structured process for measuring value, it would be advisable to establish a value measurements guideline for managing the value of agile project management.
- It is recommended that the company includes the agile project management methodology in a specified project management guideline to be established. In the guideline it should be clear to the project manager how each project management approach should be implemented.
- More focus on project manager methodologies and measuring value in projects and processes should be incorporated in workshops as most current project managers have all established not to be implementing a project management methodology and unaware of specific value measures. In order to make value measurements more explicit, project managers should be provided with clear steps to follow for each project type.
- It is recommended that senior management identifies which types of projects are currently establishing insufficient value. These projects should be analyzed and discussed during interactive workshops. This will allow root causes of value drawbacks to be established and will allow project managers to identify themselves in these situations more easily and be able to react quicker.
- It is recommended that senior management and more advanced project managers supervise newer project managers and help identify the common value drawbacks and optimization strategies.
- It is recommended that more resources are made available in order to also be able to implement the agile project management methodology and provide appropriate project rooms.
- It is recommended that senior management as well as project managers involved with the clients should make it clear and make the clients aware of the problems in current project management and necessity of a more flexible project management approach.
- It is recommended that the project managers organize specific training in order to make sure that everyone in the project team is aware of the methodology that will be applied throughout the project and also know how to apply the methodology. Thereby ensuring employees do not only apply the methodology in case of an emergency.

Recommendations for Further Research

Overall, this research contributed to a further understanding of the agile project management methodology. The research focused on the added value in which agile project management would also be applicable to the construction industry. As there was limited literature on the applicability of agile in construction, recommendations for further research can be established. Additionally, value management in the construction industry is often completed implicitly. Thereby the development of the value measurement criteria also calls for further research.

- As this research did not include the client's point of view it would be interesting to develop this research by acknowledging the clients view on implementation of agile project management as well as the added value of the methodology.
- As this research was limited to implementing agile project management in early project phases, it would be interesting to investigate on the value of agile project management in further stage project stages.
- As due to time limitations the value measure criteria were limited, it would be interesting to investigate more criteria and distinguish if there is a difference per project management methodology.

- As the value methods and tools provided were based on infrastructure projects, it would be interesting to investigate value tools specifically applicable to agile project management.
- As this research was investigated at a company not implementing agile project management, it would also be interesting to perform this research at a company already experienced with agile project management in construction and comparing the added values.
- Moreover, as the expert validation was based on project managers with sufficient experience in infrastructure, the model was limitedly validated. It would have been interesting to validate this model with agile experts.
- As this research was based mostly on results from people unaware of agile project management, it would be interesting to repeat the research and include more project managers experienced in agile project management. The outcomes could be compared and the research could focus on exploring the differently viewed opportunities by employees aware and unaware of agile project management.
- As the model now shows how agile project management can be implemented in the construction industry, it will also be interesting to research upon how agile can be implemented on an organizational level for the construction industry.
- As this research focused on large and complex infrastructure projects, it would also be interesting to research upon how the model should be altered in order to be suitable for smaller infrastructure projects.

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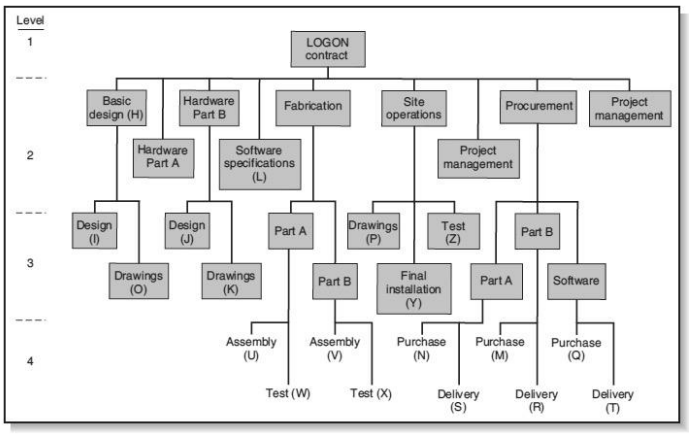
APPENDICES

Appendix A1: Conventional Project Management

Work Breakdown Structure (WBS)

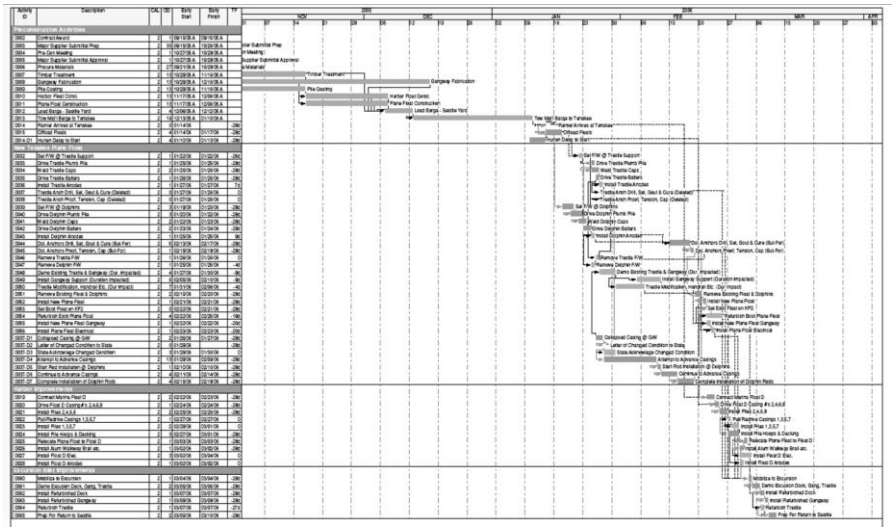
A well-known tool used for current practices is the WBS. This tool breaks the main project up into smaller projects called work packages. By dividing the work up into smaller projects, it is easier to prepare schedules, budgets and to assign management and tasks responsibilities (Nicholas & Steyn, 2012). The figure below provides an indication of what a WBS could look like, with the different possible activities that are arranged in a hierarchical manner.



Example of a WBS (Nicholas & Steyn, 2012)

Gantt chart

After the activities are known, a Gantt chart can be completed in order to schedule the different activities and visualize the project process. This form is most common as it is simple to make and use. The horizontal scale divides up the time, and the vertical scale shows the project elements.



Example of a CPM scheduling in a Gantt chart (Cherf, 2015)

Once the project has started, the Gantt tool can check the status of work elements on an individual level as well as project as a whole (Nicholas & Steyn, 2012). By placing a vertical line, one will be able to see which activities were supposed to already be finished and which should be worked on currently.

Appendix A2: Agile Project Management Characteristics and Activities

(Beck et al., 2001)	(Inayat, Salim, Marczak, Daneva, & Shamshirband, 2015)	(Campanelli & Parreiras, 2015)	(Wang, Conboy, & Pikkarainen, 2012)	(Vinekar et al., 2006)	(Jalali & Wohlin, 2012)	(Shastri, Hoda, & Amor, 2016)
Continuous improvement	Review meetings and acceptance tests	Integrated Dev/QA	-	Feedback sessions	-	Review meetings / continuous improvement
-	Retrospectives	Retrospectives	Retrospectives	-	Retrospectives	Retrospectives
-	Iterative requirements	Iteration planning	-	Iterative	Sprint/iterations	Iterations
-	Testing before coding	Unit testing	Testing first	-	Test Driven Development	-
-	Code refactoring	Refactoring	Refactoring	-	Refactoring	-
Face-to-face communication	Face-to-face communication	-	-	-	One team/sit together	Face-to-face communication
-	-	Daily stand-up	Stand-up meetings (daily)	-	Stand-up meetings	Daily stand ups
-	-	Small release planning (sprints)	Planning game (sprint planning)	-	Sprint planning	Sprints
-	-	Customer involvement	On-site customer	High-customer involvement	Onsite / proxy customer	-
Change is welcome	Change Management	-	-	Adaptable	-	Adaptive
-	Pairing for requirements analysis	-	Pair programming	-	Pair programming	-
People interaction	-	-	-	People Centric	-	People Oriented
-	-	Continuous Integration	Continuous integration	-	Continuous integration	-
-	Shared conceptualizations	-	-	Collaborative work	-	Collaborative development
-	-	Cross-functional teams	-	Multidisciplinary skills	-	Cross-functional
Simplicity	-	-	Simple Design	-	-	Simplicity
Self-organized teams	-	-	-	Self-management smaller teams	-	Self-Management teams
-	Requirements prioritization	Dedicated product owner	-	-	-	Prioritize activities/requirements
Deliver frequently	-	-	-	Short durations and delivery frequently	-	Short iterations
-	-	-	Collective ownership	-	Collective code ownership	-
-	-	Coding standards	-	-	Coding standards	-

-	Evolutionary development requirements	-	-	Evolutionary development	-	-
-	Minimal documentation	-	-	Copious documentation less important	-	-
-	-	-	-	Incremental approach	-	Incremental approach
-	-	-	-	-	User stories	-
-	-	-	-	-	Burn down charts	-
Early and continuous delivery of valuable projects	-	-	-	-	-	-
Motivated people	-	-	-	-	-	-
Working systems is progress	-	-	-	-	-	-
Constant pace	-	-	-	-	-	-
Technical excellence and good design	-	-	-	-	-	-
-	Prototyping	-	-	-	-	-
-	Requirements modeling	-	-	-	-	-
-	Continuous planning	-	-	-	Planning game	-
-	-	Automated builds	-	-	-	-
-	-	Digital task board	-	-	-	-
-	-	Open work area	-	-	-	-
-	-	-	40-hour week	-	-	-
-	-	-	-	-	Sprint review/ demo	-
-	-	-	-	-	Scrum of scrums	-
-	-	Velocity	-	-	-	-
-	-	-	-	-	Backlog	-
-	-	-	-	-	Continuous/ automated testing	-
-	-	-	-	-	Architecture Focus	-
-	-	-	-	-	Enough documentation	-
-	-	-	-	-	Scrum master	-

Agile project characteristics and activities

Appendix A3: Agile Project Management Methods

	EP	Scrum	Crystal	FDD	LD	ASD	DSDM
(Lindstrom & Jeffries, 2004)	√	√	√	√	√	√	√
(Zhi-gen et al., 2009)	√	√	√	√	-	√	√
(Bass, 2016)	√	√	-	√	√	-	-
(Conboy & Fitzgerald, 2010)	√	√	√	√	√	-	√
(Vinekar et al., 2006)	√	√	√	√	-	√	√
(Hoda et al., 2011)	√	√	√	√	-	√	√
(Shastri et al., 2016)	√	√	√	√	√	√	√

*EP=Extreme Programming; FDD=Feature-Driven Development; LD = Lean Development; ASD= Adaptive Software Development; DSDM= Dynamic Systems Development Method

Overview Agile Methods ICT

Scrum

The scrum methodology is a framework used for developing and sustaining complex projects (Schwaber & Sutherland, 2016). In particular, the methodology focuses on collaboration, self-management of teams and flexibility in order to attain an adaptable attitude (Tilk, 2016).

In the scrum guide, published by Schwaber and Sutherland (2016), the definition of scrum is provided as: "*A framework within which people can address complex adaptive problems, while productively and creatively delivering products of the highest possible value*" (Schwaber & Sutherland, 2016). As the guide states, it is important to realize that the methodology is not a process or technique to build products, rather it is a framework within which one uses to be able to employ various processes and techniques. The methodology clearly illustrates the project management and areas of improvements (Schwaber & Sutherland, 2016).

Scrum roles

The scrum team consists of three main roles, being: a product owner, the development team, and a scrum master. The team must be an self-organizing team and cross-functional (A.; Jalali Sohi et al., 2016). A short description of these three roles will be provided below, followed by an explanation of the different tasks involved in the scrum methodology (Schwaber & Sutherland, 2016).

Product Owner

A product owner represents the customer(s) involved in the project. Based on the requirements, the product owner makes sure that customer-centric items (user stories) are delivered to the scrum team, prioritizes the items, and adds additional items to the product backlog (Martinelli & Milosevic, 2016). Regarding the roles from the traditional manner, the product owner will typically be a functional unit manager or someone who knows the sequence of the project (Cervone, 2011).

Development Team

Each team focuses on a part of the final product. The team is generally self-organized and chooses how best to accomplish their work, rather than being directed by other outside of the team. The teams deliver their products iteratively and incrementally, maximizing opportunities for feedback (Schwaber & Sutherland, 2016).

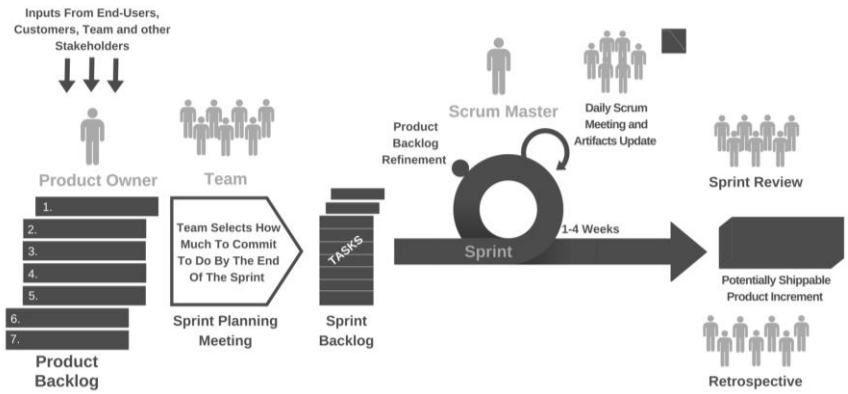
Scrum Master

The scrum master is responsible for ensuring that the scrum team adheres to the scrum theory, practices and rules (Schwaber & Sutherland, 2016). They are responsible for removing obstacles for the scrum teams so that they are able deliver their outcome. It is important to understand

that he or she is not a team manager; instead helps enforce the rules to ensure a proper process (Westcott, 2014). In traditional sense, this role will be completed by a project manager or a team leader (Cervone, 2011).

Scrum Process

The process of scrum is shown in figure below. The process is known to have five major activities: the kick-off, the sprint planning meeting, the sprint, the daily scrum, and the sprint review (Cervone, 2011) . When applying scrum the team works in short cycles called sprints. A sprint will lead to higher quality and higher customer satisfaction as the cycle provides a higher predictability for the customer and thus also influences customer satisfaction (A.; Jalali Sohi et al., 2016).



Scrum process (Pavkovic, 2016)

Product Backlog

A product backlog lists what the teams are working on as well as what the company sees as the most important items for delivering value. The ability to list everything that is desired and prioritize and reprioritize the work is necessary (Westcott, 2014).

Sprint Planning Meeting

All the work to be completed during a sprint will be planned in a sprint planning meeting. The entire scrum team creates this plan. The planning is time-boxed to a maximum of eight hours for a one-month sprint. In the case of a shorter sprint, the meeting will also be shorter. The following two questions will be answered during this meeting (Schwaber & Sutherland, 2016):

- What can be delivered in the increment resulting from the upcoming sprint?
- How will the work needed to deliver the increment be achieved?

Sprint Backlog

A sprint backlog enables the engagements and collaboration between the company and the project teams for a common understanding between all stakeholders on what will be delivered (Martinelli & Milosevic, 2016).

Sprints

The scrum methodology uses fixed-length iterations that are typically two to four weeks long. During these sprints scrum teams use a product backlog. They teams are responsible for taking on an aspect from the backlog and developing it (Martinelli & Milosevic, 2016).

Daily scrum meeting

A fast meeting, no longer than 15 minutes, that begins once the sprint-planning meeting has been finalized and agreed upon by the entire team. It involves the entire scrum team as well as the scrum master whilst attendance for the product owner is considered optional. The primary focus of a daily scrum meeting is to answer the following questions (Bass, 2016; Martinelli & Milosevic, 2016; Schwaber & Sutherland, 2016):

1. What was completed yesterday?
2. What obstacles were encountered that block me from being effective?

3. What is planned for today or prior to the next scrum meeting?

In order for the meeting to be effective, it will be important that all members prepare an answer to these questions beforehand. By allowing and encouraging every team member to answer these questions, the team will attain a thorough understanding of what is happening, an idea of the sprint progress, as well as be aware of modifications that need to be made. During the meeting, there will be a type of task board as a way of communicating the sprint progress.

Sprint Reviews
A sprint review is held at the end of each sprint in order to inspect the increment and possibly adapt the product backlog if needed. During the review all involved stakeholders collaborate about what has been done in the sprint. This is an informal meeting, the presentation of increments is intended to prompt feedback and promote collaboration (Bass, 2016; Schwaber & Sutherland, 2016).

Retrospectives
The retrospective follows a sprint review and is typically the last step in a sprint life cycle. Upon the completion of this meeting, a new sprint is created which again starts with a sprint planning meeting, followed by daily scrums, a sprint review meeting and finally another retrospective. The primary reason for these meetings is to provide the scrum team with an opportunity to analyze and review their process with the intent of improving the entire process. Thus during these meetings one reviews all the things that went well, as well as all the things that didn't go well (Westcott, 2014).

In addition to the main aspects involved in the scrum lifecycle, the scrum methodology describes two main control points for the product and sprint, being the burn-down/burn-up chart. A burn-up/ burn-down chart is used to track progress in projects. The chart measures the total in-scope work, the amount of work that should have been completed and the work actually completed. The chart helps reveal where the projects' efforts are focused and where they should be focused (Tilk, 2016).

Scrum values
Furthermore, the scrum methodology recognizes the values commitment, focus, openness, and respect. Once these values are embodied and lived up to by the scrum team, the scrum pillars of transparency, inspection, and adaption will come to life and will ensure trust for everyone (Schwaber & Sutherland, 2016).

Lean Development (LD)
In recent years attention has been given to lean development in addition to the agile methods such as scrum. Lean Development is a common variant to scrum and consists of start-up, steady state, and transition or renewal project phases (Tilk, 2016). The difference between the terms agile and lean is that agile focuses more on being flexible and being able to adapt as quickly as possible whilst lean focuses on being efficient and eliminating waste (Boehm & Turner, 2004). Thus lean defines itself as perfection through tuning the process in order to improve the project process flow. Alternatively, agile defines itself as change – being able to adapt products the entire time until total satisfaction is achieved. Lean thinking provides a way to make processes more satisfying through providing immediate feedback and transforming waste into value (van Ede, 2016; Womack & Jones, 2003).

The main focus of lean thinking is not prescriptive, instead open-ended in reaction to understanding the complex and dynamic manner of projects in the construction industry (Bertelsen & Koskela, 2004). The lean methodology aims to deliver value to the customer at a quicker pace through waste elimination. To explain the waste focus point, lean has established some interlinked principles to guide the development are provided in the table below (Hibbs & Jewett, 2010; Wang, Conboy, & Cawley, 2012; Womack & Jones, 2003).

Principles	Meaning
Value	Defined by the customer. Understand what adds value for the customer.
Value Stream	A map that identifies every step in the process and categorizes each step in

	terms of the value it adds. Understand how the organization generates customer value
Flow	It is important to maximize speed and minimize cost by achieving continuous flow
Pull	Customer order pull-product. Value is delivered on a just-in-time basis based on actual customer demand.
Perfection	Striving for perfection in the process by continuously identifying and removing waste. Continuously improving the performance of your value streams.

Lean Development Principles

These principles have been translated to nine different tools. The lean tools are used to identify non-value-added project phases and production steps. The purpose of the tools is to increase capacity, improve throughput, reduce cycle time and eliminate waste (Westcott, 2014).

1. Cycle-time reduction
2. Five S
3. Just-in-time (JIT)
4. Kanban
5. Value Stream Mapping
6. Single-Minute exchange of die (SMED)
7. Poka-yoke
8. Kaizen
9. Overall Equipment Effectiveness (OEE)

Tools Lean Development

In the construction industry, lean consists of a complex mix of different ideas followed by techniques such as continuous improvement, flattened organization structures, teamwork, elimination of waste, and efficient use of resources (Bryde et al., 2012). Hence only the tools that focus on the different themes as mentioned above and also in early project phase activities of construction projects are explored. The remaining tools are simply defined in the table below.

Tools	**Meaning**
Cycle Time Reduction	Reducing the amount of time necessary in production processes by analyzing the time needed for activities.
Five S	Includes five practices for maintaining a clean and efficient workplace (sort, set in order, shine, standardize, sustain).
Just-in-Time (JIT)	Required planning system that provides for the delivery of material or product at the exact time and place where the material or product will be used. Therefore eliminating excessive buffer stock.
Kanban	Used in the manufacturing industry to signal a supplier that more material or products are needed. It is also referred to as a pull system as its purpose is to pull material or product from a supplier rather than relying on a scheduling system to push the material or product forward at predetermined intervals.
Single-Minute Exchange of Die	This tool is also referred to as single-minute exchange of die (SMED) and aims to improve setup/changeover times, initiate a plan-do-check-act approach in production.
Poka-Yoke	This tool is an analytical approach that identifies where human errors could occur during a process and tracking it down to its original source.
Overall Equipment Effectiveness	This tool is a method for measuring efficiency and effectiveness of a process by breaking it down into three components: availability, performance, and quality.

Lean Development Tools outside the early project phases construction industry scope (Westcott, 2014)

Kaizen

This tool is also referred to as continuous improvement. The aim of this tool is to encourage employees to work together proactively and to achieve regular, incremental improvements. Therefore addressing a problem together within an organization. The meetings with employees

are completed in cross-functional teams and focuses on a target process, studies it, collects and analyzes data, discusses improvements alternatives, and implements changes (Westcott, 2014). By applying this tool improvement can be achieved as well as employee morale, creativity, and motivation. During this meeting the '5W' are discussed: who, what, where, when, why and also followed by how.

Many companies are applying kaizen in terms of a kaizen blitz or a burst, which are led by experts in order to create a change in a short space of time. Often this tool is applied in response to a crisis within a company rather than as a need to continually improve their processes. Thus in order to summarize, the following key features of the tool are displayed (Abrahamsson, Warsta, Siponen, & Ronkainen, 2003):

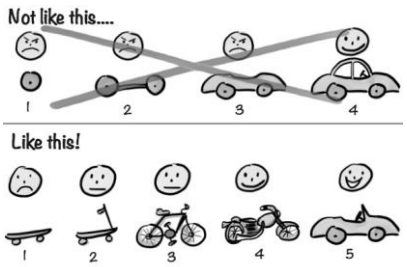
- Improvements are based on many small changes rather than radical changes
- As ideas originate from the employees themselves, they are less likely to be radically different, thus possibly easier to implement
- All employees should continually be seeking ways to improve their own performance
- Successful implementation requires active participation
- It generates enthusiasm due to close involvement of solution seeking

Value stream mapping
Value stream mapping visualizes all activities involved in designing, ordering, producing, and delivering products or services to a customer. A VSM is used to identify areas for improvement by eliminating activities that do not add value as well as specific processes that add value (Westcott, 2014). It can help determine elements of waste that could be removed in order to improve overall efficiency of a project process. Examples of processes that produce waste are unused spaces, excess inventory, storage and rework.
A typical value stream map includes visual maps of the process and follows the following steps (Griffiths, 2012):

1. Identify the product or service that needs to be analyzed
2. Create a VSM of the current process and identify steps, queues, delays and information flows
3. Review the map to reveal delays and wastes
4. Create a new VSM of the future state which displays the optimized process
5. Develop a roadmap to create the optimize state
6. Revisit the process in the future to continually tune and optimize the process

The map uses simple graphics and icons to illustrate for example the movement of material, information, inventory, and work-in process (Munro, Ramu, & Zrymiak, 2015). By analyzing the map (value stream analysis) one can uncover hidden wastes.

Next to these tools, in order to create value it must first be identified. Lean development must therefore start with a conscious attempt in identifying value as a step-by-step in the development of a project (Womack & Jones, 2003).



Metaphorical example of Lean Development (Ageling & Kniberg, 2015)

The picture is taken from an example explaining lean in its original context, the car manufacturing industry. Basically, what the picture it portraying is leans' main focus: delivering value incrementally step-by-step. By doing do, certain forms of waste will need to be eliminated.

Lean development considers seven types of waste that must be avoided, being (Hibbs, Jewett, & Sullivan, 2009; Poppendieck, 2011):

Forms of waste	Waste Description	Hypothetical examples
Defects	Documents that need correction	Unrealistic designs that need to be altered
Extra processes	Extra activities that do not add value to the project process	Unused documentation, Planned activities that did not happen in the end
Extra Features	Developing aspects of a project that might be included in the final design	Extra unnecessary work, only develop for the near future
Waiting	Delays and waiting for reviews and approvals	Prioritizing other activities over reviews
Requirements	Beginning to end full detailed requirements list and detailed report	As aspects are bound to change, this is not efficient
Finding Information	Communicating or moving information/deliverables from one group to another	Non co-located teams can cause unnecessary misunderstandings
Handoffs	Inform the customer about alterations later on in the process	Waiting for a milestone meeting to inform the customer about the delays or changes

Forms of waste

In order to understand the lean development in practice Wang, Conboy and Cawley (2012) have identified several lean practices. These practices are taken from the tools applicable also in non-manufacturing industries (Wang, Conboy, & Cawley, 2012): address bottleneck, defer decision making, continuous improvement to establish a smooth flow, make everything transparent, reduce slack, root cause analysis, use pull-systems and value stream mapping.

Dynamic Systems Development Method (DSDM)

Throughout the development process, designers using the DSDM approach have an increased interest in the edge case instead of a project ingredient. This means that for DSDM one considers it to be more important to know what choice to make when time constraints are applied. The DSDM acquires nine principles in order to implement the method, which are displayed below (Voigt, 2004).

1. Active user involvement is imperative
2. Teams must be empowered to make decisions
3. Focus on frequent delivery
4. Fitness for business is criterion for accepted deliverables
5. Iterative and incremental development is mandatory
6. All changes during development must be reversible
7. Requirements are base-lined at high level
8. Testing is integrated throughout the lifecycle
9. Collaborative and Co-operative Approach

Principles DSDM

The methodology prioritizes schedule and quality over functionality. There are two main recommended core techniques with DSDM, being: time boxing and MoSCoW.

Timeboxing

Time boxing is comparable to milestone planning in conventional project management methodologies, however it is usually no longer than six weeks. Within these six weeks a given set of tasks should be achieved. The aim is to estimate near-future events/ project components involving a small set of tasks better (Voigt, 2004). Some important attributes for time boxing are:

- Time boxes can be of different lengths
- Parallel time boxes are possible
- Different DSDM phases can be realized in one timebox

With timeboxing one decides upon goals within a certain timeframe and consequently fixes the time (this is the most important factor and cannot be altered). Meaning that each team member must continuously prioritize goals or tasks (Johansson, 2012). This also means that if certain tasks are not completed due to re-prioritization the tasks will not simply be skipped but instead executed in the next cycle. By fixing the time, one will quickly be able to notice if the project is falling behind on schedule and react immediately (Johansson, 2012).

MoSCoW
The prioritization method that applies to DSDM is MoSCoW, which breaks a project down into four different types of requirements (Griffiths, 2012; Hass, 2007; Powell-Morse, 2017):

- Must have (M)
- Should have (S)
- Could have (C)
- Want to have (W)

The group includes features that must be implemented, followed by the second group which includes important features that contribute significant value but can still be omitted if time constrains endanger the overall delivery. The third type being could have, includes features that are definitely add functionally but can also be easily re-assigned to a later cycle. Lastly the want to have type includes features that are only valuable to a limited group of users and are considered the least important.

Hypothetical extra methods/aspect of methods
Apart from the methods and their tools as mentioned above, the remaining tools that were not recognized in literature specifically describing the practices in the construction industry, also state several actions that could potentially also be beneficial. In the table you will be able to find under which methods color-coding, open workspaces, and pair programming belong.

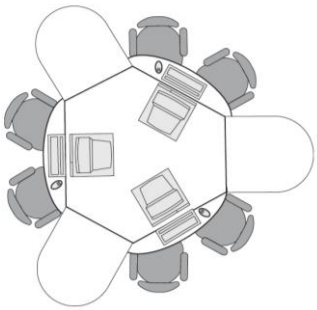
Color-coding
This method can be applied in various stages of the process. It asks people to think back over the iteration/release/project and remember all the memorable, personally meaningful, or significant events. In order to gather both facts and feelings, colors are used to represent emotional states, events, functions, and themes.

Color	Coding Feelings	Coding Events	Coding Functions	Coding Themes
Blue	Sad, mad, bad	-	Developers	Equipment usage
Red	Challenged, stalled	-	-	-
Green	Satisfied, successful, energetic	Organization related	Q&A and testing	Engineering practices
Yellow	Cautious, confused	Technical/ technology related	Technical writers	Team communication
Purple	Fun, surprise, humor	-	-	-
Pink	Fatigued, stressed	People or team related	Customers	Relationships with customers

Color-coding (Derby & Larsen, 2006)

There are many variations to the colors used, however the main message they all portray is that to get an indication about what people are valuing to be going wrong, bad, or good and given them energy a lean planning sessions or daily scrum sessions might not be enough to visualize this properly. This method provides an extra step on top of the daily scrums and way of planning through including motivational factors and emotions.

Open workspace
This activity encourages large rooms with tables in the center that can typically seat two to four pairs of developers. In extreme programming this is illustrated as the figure below shows.



Open workspace IT (Lindstrom & Jeffries, 2004)

Generally people involved with projects in the construction industry do not need to be paired all the time, but in order to encourage collaboration, fast delivery, etc. the workplaces on-site will also need to be designed to allow this type of teamwork. In all the other tools, the design of the location is not described, just simply that people need to work at the same location. However if the location consists of many small 1-2 people offices and no open meeting/ working spaces the intended collaborative attitude will most likely be disrupted. Just like with ICT projects, in the construction industry many of the tasks are interrelated and must be discussed to avoid reworking of components.

Appendix A4: Best Value Procurement/Approach

For many years the procurement of projects has been carried out under traditional low-bid approaches. In this traditional manner, experience overruns in terms of time and cost which can be due to the subjective bias in clients' selection mechanisms (Hasnain & Thaheem, 2016). As literature presents, the majority of public sector construction contract remain to be rewarded solely based on the lowest price (Scott & Program, 2006; Tran, Molenaar, & Gransberg, 2016; Wong, Holt, & Cooper, 2000). A long-term concern for this is that the lowest bid may not result in the best value for money and performance during and after construction. A lowest bid encourages contractors to implement cost-cutting measures instead of quality enhancing measures.

The best value approach is defined as a procurement process where price and other key factors are considered in the evaluation and selection process to minimize impacts and enhance the long-term performance and value of construction (Scott & Program, 2006; Tran, Molenaar, & Gransberg, 2016; Tran, Molenaar, & Kolli, 2016). Best value is an efficient and effective approach that is able to create a 'win-win' scenario. The method encourages value for money and performance criteria in order to focus on best practices for projects (Hasnain & Thaheem, 2016).

The approach is increasingly being recognized at Witteveen+Bos although it requires a culture change, as the approach is a gradual long-term process. The success of best value depends on a number of attributes, including the ability to adopt a critical attitude to identify problem areas to be able to access cost-effective solutions, establish proper lines of communication, share knowledge internally and externally and set new targets (Akintoye, Hardcastle, Beck, Chinyio, & Asenova, 2003). An advantages recognized in literature when applying BVP is minimizing risks of nonperformance (Hasnain & Thaheem, 2016). The BVP requires decision makers to agree upon key project criteria during the early project phase whilst focusing not only on costs but also value and quality.
Some identified best value evaluation criteria used in past projects are (Perrenoud, Lines, Savicky, & Sullivan, 2017): Cost, time, quality, design alternatives, and performance.
These criteria are in line with the criteria that shall be used for the evaluation of project value as previously stated.

Numerous researchers have mentioned the essential contract selection criteria. Project-specific criteria for civil engineering works that are considered to be most important are (Perrenoud et al., 2017; Wong et al., 2000):

1. Ability to complete on time
2. Site organization, rules and policies (health and safety etc.)
3. Maximum resource and financial capacity
4. Training or skill level
5. Actual work quality achieved on similar works
6. Ability to deal with unanticipated problems
7. Financial arrangements
8. Quality and quantity of human resources
9. Quality and quantity of managerial staff
10. Proposed construction method

The disadvantages recognized by literature about BVP is that the process may take longer than a conventional project approach (Tran, Molenaar, & Gransberg, 2016). Additionally in order to overcome the subjective nature of best-value selection, clear evaluation plan need to be required (Tran, Molenaar, & Kolli, 2016).

As Witteveen+Bos sometimes uses this approach as a way to measure value and to ensure value is continuously important in projects, this methodology shall be taken into consideration when analyzing the interview and survey results.

Appendix A5: Organizing Agile Elements

Altogether these are all the elements that were found to characterize the agile project management methodology in its values, common practices, methods, and principles meant for the ICT but can possibly be implemented into the construction industry.

	Agile Characteristics	28	Transparency
1	Feedback sessions and reviewing to continuously improve (Q&A)	29	Trust
2	Retrospectives	30	Openness
3	Iterations	31	Scrum board
4	Frequent face-to-face communication	32	Product backlog
5	Sprint planning (small releases)	33	Burn down chart
6	High customer involvement on-site	34	Short innovative brainstorm sessions
7	Adaptable projects (change management)	35	Visualizing activities
8	People-oriented	36	Eliminating activities with less priority
9	Collaborative development (helping each other)	37	Team empowerment
10	Cross-functional teams	38	Focus on frequent delivery
11	Simplicity in designs	39	Collaborative approach
12	Self-management of teams (small teams)	40	Prioritizing activities
13	Re-prioritizing requirements and activities	41	Prioritizing requirements
14	Frequent deliveries in short iterations	42	Color-coding themes
15	Evolutionary development	43	Open workspaces
16	Minimizing documentation		**ICT Agile Principles**
17	Incremental approach	44	People interaction
	Agile Methods	45	Continuous improvement
18	Time is fixed	46	Face-to-face communication
19	Reprioritizing of activities	47	Change is welcome
20	Cross-functional teams	48	Simplicity
21	Many small teams	49	Early and continuous delivery of valuable projects
22	Self-management of teams	50	Deliver frequently
23	On-site	51	Motivated people
24	Daily stand ups	52	Working systems is progress
25	2-4 week sprints	53	Constant pace
26	Timeboxing	54	Technical excellence and good design
27	Scrum retrospectives	55	Self-organized teams

Elements Agile Project Management from literature (Values, Common Practices, Methods, Principles)

Interview Questions

General Information

Subject:	**Orientation Interview**	**Date:**	
Interviewer:	A.M.C. van Kralingen	**Time:**	
Interviewee:			

Introduction

Interviewer:

- MSc. student CME
- Objective graduation research
- Research context

Interviewee:

- What department do you work at? What is your current function within this department?
- How many years of experience do you have?

Projects

1. What kind of projects do you usually perform? What are your tasks within these projects?
2. How big/complex are the projects you are involved in?
3. Which phase of projects are you involved in?

Early Project Phases

4. Which project phases are you involved in? (If not in EPP – do you know colleagues that do?)
5. In your experience, what activities belong in early project phases?
6. How much time is reserved for early project phases?
7. How many (external) parties are involved?
8. Usually, how many employees from Witteveen+Bos are involved in a project during the early project phase?
9. Do you follow your own project management or do you follow standard guides such as PMBOK/PRINCE2? Is there a project management manual at Witteveen+Bos?
10. Do the activities that you perform for early project phases differ per project or do you perform the same activities?

Value

11. How would you define value?
12. How important is it for Witteveen+Bos to define value and control of value delivery for each single project?
13. Is the value of each project different? (Project-level point of view and organizational-level point of view)
14. Do you know/use any known value management methods/tools? If yes which ones and why?
15. Do you distinguish a difference between value of a project and value of project management processes?
16. How would you define value in projects? & value in project management processes?
17. Do you measure value of project management processes? If so, how do you measure value? (refer to question 5 - activities)
18. How do you make sure value is delivered?
19. Do you think there is a difference between value delivery for the client and value for Witteveen+Bos?
20. Is the focus more on delivering to the client or the company, Witteveen+Bos?
21. Where do you think the drawbacks are in delivering value at Witteveen+Bos (and to the client in case you consider there to be a difference)?
22. Do you have ideas on what W+B should change in order to deliver the most value for the project and the process?

Project Management

23. Are you familiar with agile project management? Have you used agile?
24. If you have used agile, what was the result? & if not, why?
25. What are the problems you experience in your current project management practises?
26. What do you think should change for these problems to be avoided?

Appendix B2: Case Study Interview Protocol

General Information

Subject:	Case study XX	Date:	
Interviewer:	A.M.C. van Kralingen	**Time:**	
Interviewee:			

Introduction

- Interviewee:

Occupation	
Degree of education	
Department	
Years of experience	
Type of projects	
Project roles	

- Objective graduation research
- Case study introduction

Early Project Phase

1. In your experience, which activities belong in the early project phase of this project?

Activiteit	
Opstellen startdocument	
Samenstellen projectorganisatie	
Kosten-baten analyse	
Varianten studies	
Milieu-effecten rapport	
Probleemanalyse	
Beoordelingsfase (alternatieven selecteren)	
Besluitvormingsfase (bestuurlijke verankering en voorkeursbeslissing)	
Contract vorm	
Vergunningen traject	
Additional?	

2. How big was the project team involved? What was everyone's role?
3. How much time was reserved for this phase? Was this an accurate planning or were there overruns?
4. How many (external) parties were involved?
5. Do you follow your own project management or do you follow standard guides such as PMBOK/PRINCE2?
6. Are you involved in the PMP for this project? Is this checked and adjusted during the process of the project or only at the end?

Value Management

7. How would you define value for this project?
8. How do you make sure value is delivered for this project?
9. How important is it for Witteveen+Bos to define value and control value for this project?
10. Do you distinguish a difference between value of a project and value of a project process?
11. What are the criteria for measuring value for projects and processes in this project?

VALUE MEASURES CRITERIA

PROJECT	**(1)**	**(2)**	**(4)**	**PROCESS**	**(1)**	**(2)**	**(4)**
Cost of a project				Scheduling			
Timescale				Stakeholder satisfaction			
Scope				Project teams			
Quality				Budgeting			
Customer satisfaction				Performance information			
				Resources			
				Scope			
				Communication			
				Risk			
				Quality			

				Individual attitudes			
				Managing changes			
Others?				*Others?*			

(1) Which criteria do you measure?
(2) How is the project valued in terms of the criteria you measure for projects and processes? (Below expectation – Above expectation -> Scale 1-5)
(3) Which criteria do you not measure and why not?
(4) Which criterions are currently not measured but could make considerable differences if it were to be taken into account?
(5) Are there other criterion not mentioned on this list that you measure?

12. How do you measure value in projects and project processes? (Regarding the criteria stated in the previous question)

PROJECT VALUE CRITERIA MEASURES

Criteria	Method	Tool	Criteria	Method	Tool
Cost of a project	Forecasting		***Quality***	Effectiveness of project	
	Performance Reviews			Efficiency of project	
		Earned Value Analysis		Plan & Define requirements achieved	
		To-Complete Performance Index (TCPI)			Quality Assurance
		Reserve Analysis			Conflict Management
		Milestone Analysis	***Clients + Stakeholders Satisfaction***	Emotional response to outcome of process	
		Budget Consumption Chart		Degree of focus on customer	
		Cost Management Plan		Involvement throughout the process	
Timescale	Project duration review				Ratio results compared to expected
		Schedule Performance Index			
Scope	Functionality delivered as agreed upon?				
		Evaluations			

PROCESS VALUE CRITERIA MEASURES

Criteria	Method	Tool	Criteria	Method	Tool
Scheduling	Documentation		***Communication***	Formal reports	
	Time buffers			Action plan	
	Scenario Planning			Project Management Plan	
		Activity Network Diagrams			Design Structure Matrix
		Gantt Chart			Peer reviews
		Timeboxing			Stand-up meetings
		Critical Path Method	***Risk***	Identifying risks	Risk Management Plan
		Burn down chart			Risk Register
		Buffer chart			Risk Assess Matrix
		Milestone prediction chart			Monte Carlo
		B-C-F Analysis			Decision Tree
Clients + Stakeholders Satisfaction	Engagement				Risk adjusted backlog
		Balanced Scorecard			Risk Impact Assessment
		Clients' valued			Risk Prioritization

		prioritization			Analysis
		Prioritization ranking	***Quality***	ISO 9001 Quality Management	
		Stakeholder mapping			Value stream mapping
Project Teams	Coordination				Cost-Benefit analysis
	Mutual trust				Pareto diagram
	Balance of team member contribution				Quality Assurance
		Trainings			Value-driven KPI's
Budgeting	Cost forecasting				Best Value Approach
		Activity based costing	***Individual attitudes***	Innovation and learning	
		Earned Value Analysis		Motivation	
		Planned / Actual costs in Excel		Participation	
Performance Information	Openness to stakeholders and clients about progress				Thermometer approach
		Completeness of requirements	***Managing changes***	Number of interrelations	
		Cost performance index		Flexibility	
		Schedule performance index			Retrospectives
Resources		Facilities	***Others?***		
		Trainings			
Scope	Scope statement				
	Clarity of goals				
		SWOT analysis			
		Product Breakdown Structure			
		Work Breakdown Structure			

13. Do you think there is a difference between value delivery for the client and value for Witteveen+Bos in this project? What is the focus in this project?
14. Where do you think the current drawbacks are in delivering value in this project?
15. Do you have ideas on what W+B should change in order to deliver the most value for the project and the process?

Project Management

16. Are you familiar with agile project management? Have you used agile in other projects?
17. Regarding current practises, which of the following themes often causing problems?
    - Delivery:
    - Process:
    - Planning:
    - Teams:
    - Projects:
    - Clients:
    - Attitude:
    - Documentation:
    - Location:
18. Are you experiencing any specific problems regarding practices next to these elements?
19. Which of these elements can be improved in current project management practices, and how?
20. What in your opinion should be changed for these problems to be avoided?
21. If you would do this project again, what would you do differently regarding project management?

Appendix B3: Survey Protocol

Enquête Afstuderen
Toegevoegde Waarde Agile Project Management

Voor mijn afstuderen aan de Technische Universiteit Delft (master Construction Management & Engineering) doe ik, in samenwerking met Witteveen+Bos en ook deels Arcadis, onderzoek naar de toegevoegde waarde van agile project management in de verkenningsfase van infrastructurele projecten.

Door middel van deze enquête onderzoek ik welke elementen van agile project management (on)bewust al toegepast worden in infrastructurele projecten en hoe waarde van projecten en project processen momenteel getoetst wordt. Het is belangrijk dat u één project in gedachte houdt tijdens het invullen van de enquête. Mocht u al ervaring hebben met scrum of LEAN planning, dan graag dit project gebruiken. Mocht u nog geen ervaring hebben met deze technieken, dan graag een afgerond infrastructureel project in de verkenningsfase.

Deze enquête is opgebouwd in vijf delen: (1) persoonlijke informatie (2) project specifieke vragen (3) gebruiken van agile elementen in projecten (4) meetbare waarde criteria van projecten (5) meetbare waarde criteria van project processen.

Uw gegevens zullen volkomen anoniem behandeld worden en zullen alleen verwerkt worden in mijn eindrapport. Dit rapport kan na afronding van het onderzoek aangevraagd worden.

Alvast bedankt voor uw medewerking!

Met vriendelijke groet,

Anne van Kralingen
E: amc.vankralingen@gmail.com
T: 06-12245004

PERSOONLIJKE INFORMATIE

Naam:

Bedrijf:

Afdeling:

Aantal jaren ervaring:

Hoogst behaalde opleiding: ◯ VMBO ◯ HAVO ◯ VWO ◯ MBO ◯ HBO ◯ WO

Anders, namelijk:

Bent u bekend met agile? ◯ Ja ◯ Nee

PROJECT INFORMATIE

Het is belangrijk dat u één project in gedachte houd tijdens het invullen van de enquête. Mocht u al ervaring hebben met scrum of LEAN planning, dan graag dit project gebruiken. Mocht u nog geen ervaring hebben met deze technieken, dan graag een afgerond infrastructureel project in de verkenningsfase.

Projectnaam:

Wat was uw functie/rol?

Wat was ca. het budget?

Hoe lang duurde de verkenningsfase?

	PROJECT ERVARINGEN					PERSOONLIJKE MENING				
	Volledig mee oneens	Enigszins mee oneens	Neutraal	Enigszins mee eens	Volledig mee eens	Volledig mee oneens	Enigszins mee oneens	Neutraal	Enigszins mee eens	Volledig mee eens
Project										
Continu openstaan voor veranderingen	○	○	○	○	○	○	○	○	○	○
Bezig zijn met continu verbeteren	○	○	○	○	○	○	○	○	○	○
Gehele project opbreken in behapbare stukken	○	○	○	○	○	○	○	○	○	○
Project proberen te versimpelen door steeds korte projecten uit te voeren	○	○	○	○	○	○	○	○	○	○
Klanten										
De klant wordt met elke stap in het proces betrokken	○	○	○	○	○	○	○	○	○	○
De klant is bij de planningssessies	○	○	○	○	○	○	○	○	○	○
De klant is bij evaluatie sessies	○	○	○	○	○	○	○	○	○	○
De klant werkt ook op locatie	○	○	○	○	○	○	○	○	○	○
De samenwerking met de klant is erg belangrijk	○	○	○	○	○	○	○	○	○	○
Mentaliteit										
Project ontwikkelt zich rondom gemotiveerde mensen	○	○	○	○	○	○	○	○	○	○
Werknemers vertrouwen elkaar	○	○	○	○	○	○	○	○	○	○
Werknemers helpen elkaar	○	○	○	○	○	○	○	○	○	○
Documentatie										
Ontwijk lange extreem gedetailleerde rapporten	○	○	○	○	○	○	○	○	○	○
Plan alleen op korte termijn	○	○	○	○	○	○	○	○	○	○
Minimaliseer documentatie	○	○	○	○	○	○	○	○	○	○
Locatie										
Alle betrokken partijen werken op een locatie	○	○	○	○	○	○	○	○	○	○
Open werkplekken bevorderen samenwerking	○	○	○	○	○	○	○	○	○	○
Project ruimte waar bv planning opgehangen kan worden	○	○	○	○	○	○	○	○	○	○
Color-coding wordt gebruikt	○	○	○	○	○	○	○	○	○	○

AGILE PROJECT MANAGEMENT

In de linkerkolom kunt u uw ervaringen in het project invullen en in de rechterkolom uw persoonlijke mening (welk element is belangrijk en ziet u graag terug) voor projecten.

	PROJECT ERVARINGEN					PERSOONLIJKE MENING				
	Volledig mee oneens	Enigszins mee oneens	Neutraal	Enigszins mee eens	Volledig mee eens	Volledig mee oneens	Enigszins mee oneens	Neutraal	Enigszins mee eens	Volledig mee eens
Leveringen										
Frequente levering van producten aan de klant iedere 4 weken.	○	○	○	○	○	○	○	○	○	○
Voordurend project leveringen bijhouden en bijsturen	○	○	○	○	○	○	○	○	○	○
Proces										
Frequente levering via een iteratief proces	○	○	○	○	○	○	○	○	○	○
Evolutionair proces gericht op voortdurend verbeteren	○	○	○	○	○	○	○	○	○	○
Evaluaties na iedere levering	○	○	○	○	○	○	○	○	○	○
Bijsturen van doelen en planning	○	○	○	○	○	○	○	○	○	○
Planning										
Veranderingen zijn ook welkom in een latere project fase	○	○	○	○	○	○	○	○	○	○
Integrale planning sessies dragen bij aan raakvlakmanagement	○	○	○	○	○	○	○	○	○	○
Daily stands om de planning bij te sturen	○	○	○	○	○	○	○	○	○	○
Oorspronkelijke planning regelmatig herzien door activiteiten te prioriteren	○	○	○	○	○	○	○	○	○	○
Teams										
Meerdere kleine teams in plaats van een groot team	○	○	○	○	○	○	○	○	○	○
'Self-management' verhouding van teams	○	○	○	○	○	○	○	○	○	○
Cross-functionele teams	○	○	○	○	○	○	○	○	○	○
Teams werken op dezelfde locatie	○	○	○	○	○	○	○	○	○	○
Zo vaak mogelijk face-to-face communicatie ipv email/skype	○	○	○	○	○	○	○	○	○	○
Binnen het team en met andere teams worden vaak daily stands georganiseerd	○	○	○	○	○	○	○	○	○	○
Verspreiding van updates en informatie gebeurt altijd	○	○	○	○	○	○	○	○	○	○
Evaluatie sessies met het team worden regelmatig georganiseerd	○	○	○	○	○	○	○	○	○	○
Een goede samenwerking aanmoedigen	○	○	○	○	○	○	○	○	○	○

WAARDE CRITERIA VOOR PROJECTEN

Hoe heeft het project in de verkenningsfase gepresteerd? In de linkerkolom en terugblik op het eindresultaat, en in rechts of dit criteria ook gemeten is.

	HOE HEEFT HET PROJECT RESULTAAT GEPRESTEERD?					IS DIT CRITERIUM GEMETEN?	
	Slecht	Minder dan verwacht	Zoals verwacht	Beter dan verwacht	Heel veel beter	Ja	Nee
Kosten van het project	○	○	○	○	○	○	○
Tijd van het project	○	○	○	○	○	○	○
Scope bereikt van het project	○	○	○	○	○	○	○
Kwaliteit van het project	○	○	○	○	○	○	○
Klant tevredenheid	○	○	○	○	○	○	○

WAARDE CRITERIA VOOR PROCESSEN

Hoe heeft het project in de verkenningsfase gepresteerd? In de linkerkolom en terugblik op het proces, en in rechts of dit criteria ook gemeten is.

	HOE HEEFT HET PROJECT RESULTAAT GEPRESTEERD?					IS DIT CRITERIUM GEMETEN?	
	Slecht	Minder dan verwacht	Zoals verwacht	Beter dan verwacht	Heel veel beter	Ja	Nee
Planning	○	○	○	○	○	○	○
Tussentijdse tevredenheid van de klant	○	○	○	○	○	○	○
Samenwerking van teams	○	○	○	○	○	○	○
Budget per fase	○	○	○	○	○	○	○
Prestaties (wat is er al af?wat moet nog?)	○	○	○	○	○	○	○
Process middelen (bv. voltooide cursussen)	○	○	○	○	○	○	○
Scope (Zijn we nog aan het doen wat de klant vroeg?)	○	○	○	○	○	○	○
Communicatie	○	○	○	○	○	○	○
Benadering risico's	○	○	○	○	○	○	○
Kwaliteit	○	○	○	○	○	○	○
Passende mentaliteit	○	○	○	○	○	○	○
Veranderingen doorvoeren	○	○	○	○	○	○	○

Appendix C1: Extensive Results Case Study 1

Early Project Phase Activities

In order to get a coherent early project phase comparison, the activities in the exploratory interviews were provided to the interviewees during this case study interview. They were asked to determine which activities were also completed during this project and if there were also additional activities.

		Respondents			
		1	2	3	4
Activities	Compose start document	Yes	Yes	Yes	Yes
	Assemble project organization	Yes	Yes	Yes	Yes
	Cost-Benefit Analysis	-	-	Yes	Yes
	Scenario Analysis	Yes	Yes	Yes	Yes
	Environmental Impact Report	Yes	Yes	Yes	Yes
	Problem Analysis	Yes	Yes	Yes	Yes
	Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes
	Decision-making phase (policy anchoring and preferential decision)	Yes	Yes	Yes	Yes
	Form of Contract	Yes	-	Yes	Yes
	Permit process	Yes	Yes	Yes	Yes
Additional	Setting up a reference design	Yes	-	Yes	-
	Stakeholder analysis	-	-	Yes	Yes
	Strategic environment management	-	-	-	Yes
	Collecting client demands	-	-	-	Yes
	Government adjustment plan / planning procedure	-	-	-	Yes

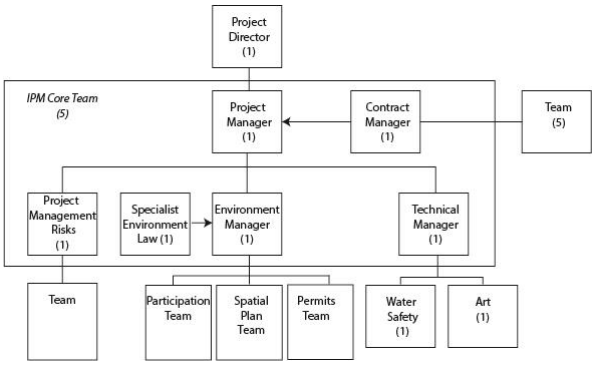
In total eight out of the ten activities as established during the exploratory interviews were also completed in this project. This indicates that this project was a typical early project phase project for W+B. All respondents were positioned outside of the core team, but closely involved as three out of the four respondents were project leaders of disciplines. Only one respondent was a specialist. As the respondents were from different disciplines, by experiencing that their activities were all in line with each other – it will be likely that the remaining project organization will have also responded in a similar manner.

The purpose of the project management plan (PMP) in this project was to illustrate to the client how the project will be organized and which activities will be completed. The plan wasn't necessarily very long (20-30 pages), but was completed upfront for the entire project. The PMP was updated after each project phase and emailed to all involved employees in the project organization. However, the project team was never confronted with the PMP in later phases. One of the respondents therefore also indicated that it would have been better to also use the PMP internally and not only during the project startup (as mentioned by another respondent). Nonetheless, even though one PMP was applied for the entire project, no particular overruns were encountered – indicating that planning upfront for two years with several updates in-between is satisfactory. This could indicate that the PMP is not a product important for internal team organization in terms of project outcome as well as the process. Or other techniques were used to update team members about the project progress and effectively keep the project results and process on track.

As the additional activities are not coherent with all of the respondents' results, they will be considered to be part of other activities in the list already provided or especially applicable to a certain project role. For example collecting client demands can also be part of the problem analysis. Additionally strategic environmental management can be part of the environmental impact report.

Project Organization

Each interviewee was asked to provide a description of the project organization and the different disciplines involved. These descriptions and illustrations put together have formed to overview of the project organization for this particular case study.



As the illustration of the project organization shows, the IPM role approach was applied. The core team of the project consisted of five main roles with one assistant specialist for environmental management. Each of the responsible managers again had a minimum of one team below them in the organization that encountered more specialized tasks. Each of the interviewees mentioned an estimate of 3-5 employees per subordinate team. In total in order to provide an indication of the size of the project, the interviewees estimated a total of thirty employees engaged in the project on a full time basis. However, taking into account all specialist work and employees who only booked a few hours on the project – an approximation of one hundred employees were involved in this project phase.

Value Measures Projects

Project Criteria Measured	**Method**	**Tool**
Cost of a project	Forecasting	CODA
Scope	Evaluations – Functionality as delivered upon?	-
Quality	Plan & Define requirements achieved	Quality Assurance

Value Measures Project Processes

Process Criteria Measured	**Method**	**Tool**
Scheduling	Progress reports, Lean planning, milestone planning	WBS, Activity Network Diagrams, Gantt Chart
Client + Stakeholder Satisfaction	Collecting requirements, progress meetings	-
Budgeting	Progress reports (1x a month), activity based costing	Planned/Actual costs in Excel
Performance Information	Progress meetings core team	Completeness of requirements, Cost Performance Index, Schedule Performance Index
Scope	Clarity of goals, PSU	Product Breakdown Structure, Work Breakdown Structure
Communication	Project Management Plan	Weekly Stand-Ups
Quality	ISO 9001 Quality Management	Quality Assurance (audits)
Risks	-	Risk Management Plan, Risk Impact Assessment
Individual attitudes	Team sessions with coach (RWS and W+B) for team building	-

In total three out of the five project measurement criteria apply to this project. For the project process this is nine out of the twelve criteria. Noticeable in this project is that a team coach was hired specifically for team building sessions. The team building sessions were completed both by W+B and the project team of the client. Hereby, effort was spent on making sure employees were (and stayed) motivated and understood each other's way of working. Also, the client and

stakeholder satisfaction was only measured during the project process through collecting the requirements and progress meetings. However the respondents have indicated that the final outcome of the projects was not evaluated with the client and stakeholders.

The respondents were also asked if they measured any other criterion next to the provided criterion for projects and processes, and also whether they thought a certain criterion was missing in the list. All the responses were consistent, namely that no other criterion should be added to the list. Correspondingly the interviewees were asked which criterion was currently not measured and they considered being important to measure. One of the respondents replied to not want to measure any others, and the other three respondents indicated that they would like to measure more during project processes. All three of their concerns were found in the individual team member, and finding a way to measure the team work and individual mentality. Thereby being able to realize when employees are feeling included (or excluded) and being able to act on this. Furthermore, one respondent also found it interesting to be able to identify different characteristics within teams and see how people work together in teams and their approach to solving issues together. As the respondents have mentioned to find it important to make sure that the project team consists of people with the right skills, they would be interested to also know about employees work methods and behavior in projects. Lastly one of the respondents mentioned to find it important to focus more on the scope (even though this is already completed) during the process, and making sure everyone within the team is doing to right thing.

Furthermore the respondents were asked if they considered there to be a difference between focus on value delivery for the client and for the company and what the focus was. Three of the respondents replied that they considered the focus to be 50-50. There is a difference but there is definitely also shared value. For the company the focus is on establishing a proper client relationship, income, and a new reference project. However as principally the work is completed for the client, one of the respondents mentioned the focus to be 80-20.
Furthermore some drawbacks in value in current practice and also opportunities were asked and have formed the following additional statements.

Most evident reasoning for implementation of agile project management
Three out of the four respondents mentioned to have never heard of agile project management. After the explanation of agile project management they still mentioned to not have explicitly used this methodology. Once of the respondents mentioned to have used APM before, however in a much smaller project. In order to identify reasons for implementing agile project management, and clarifying which aspects would work and provide value in projects, the survey results have also been discussed with the respondents. Below, the most important discussions of agile elements that were either not experienced at all (or the opposite) and/or viewed to be/ or not to be important in projects. These results from the respondents regarding this case study have been summarized according to the themes as stated in the survey.

Deliveries:

- Deliveries every four weeks will not be necessary at all times in the project. The progress in projects is not always constant and therefore deliveries also vary. There is not standard frequency of exact product deliveries.
- It would be better to evaluate products more and receive remarks from the client. It would be good to guide the expectations by evaluating more and thereby being able to also alter upfront requirements in time if necessary. However the evaluations should not take place for every small product as then the evaluations will become too intense and time consuming (and possible taken less serious).

Teams:

- Project rooms are often not large enough for everyone to be able to work there. Therefore teams are often not working at the same location. It would be better if team members meet more regularly. In order to find a solution for the project room it would be better to either find larger project rooms or make sure the different project teams are at least in the opportunity to use the project room at set times.
- Face-to-face communication often lacks in projects, but is very important for trust, teamwork, and motivation. It would be more of an advantage to be able to work together more often at the same location.

- Daily stands within teams is simply most of the time unnecessary. Projects often last a few years which also means that the people involved cannot (or should) spend every day working on that particular project. Stand up meetings within teams should only be arranged when necessary.
- Evaluation sessions were not organized structurally, however this would be better to do in the future with projects.

Project:

- Being open to changes is not only asked for on our side but also on the client's side. Sometimes if we are open to last minute changes, the client can still hold on to original requirements and evaluate us less nicely. This can be a reason to make us resistant to changes.

Clients:

- The client is not always involved in planning sessions, which should be organized more often. However the client should only be involved when necessary, for example at the start of a new phase. Inviting the client during phases can also be disrupting. For this project we only included the client more towards the end of the project, however it would have been better to have done this regularly right from the start. Approximately once a month will probably be enough for the client to be accurately updated on the project planning and have adequate influence during the sessions.
- In this project we did not experience the client attending evaluation sessions, only towards the end of the project. It would have been better if this was completed right from the start and also on a more regular basis.
- The client did not work at location mainly due to the many project phases which were not all interesting to the client. As the project progressed, the client was more involved. It would have been better to do this more regularly (but still decide upon when it is interesting for the client to join discussions and work on-site).

Documentation:

- Long and detailed reports should be avoided as the information can also be provided in a concise manner to the client. As long as they are appropriately involved, it will be acceptable to deliver short and more concise reports.
- Planning should be performed only for the short term as long as the long term planning also exists. The short term planning should be performed in relation to the long term planning.
- Minimizing documentation should only be performed as long as this enables no loss of important information. A good balance should be found in when extensive documentation is needed and when documentation can be minimalized.

Location:

- Employees should start working more at the same location. However for this to be possible, enough space should be available as well as a project room.
- More open work spaces should be encouraged. The offices now are encouraging this more, but during this project this opportunity was not there yet. An open arrangement encourages collaboration.

Appendix C2: Extensive Results Case Study 2

Early Project Phase Activities

As during the exploratory interviews the activities belonging to early project phases were asked not specifically related to one project, the same question was asked. The proposed activities from the first set of interviews was given to the interviewee, who was then able to identify which activities were also performed in the particular project as well as identify additional activities.

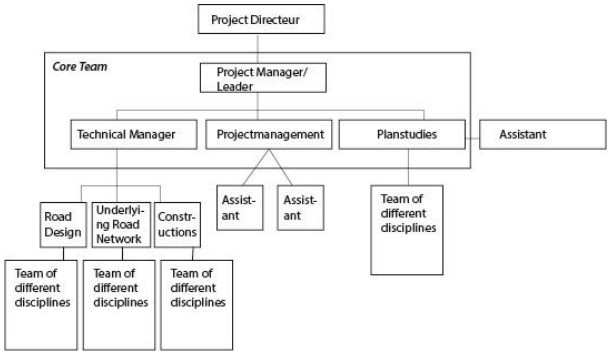
		Respondents				
		5	6	7	8	9
Activities	Compose start document	Yes	Yes	-	Yes	Yes
	Assemble project organization	Yes	Yes	Yes	Yes	Yes
	Cost-Benefit Analysis	-	-	-	Yes	-
	Scenario Analysis	Yes	Yes	Yes	Yes	Yes
	Environmental Impact Report	Yes	Yes	-	Yes	-
	Problem Analysis	Yes	Yes	Yes	Yes	Yes
	Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes	Yes
	Decision-making phase (policy anchoring and preferential decision)	-	Yes	-	Yes	Yes
	Form of Contract	-	-	Yes	Yes	-
	Permit process	Yes	-	-	Yes	-
Additional	Changes in the record of decisions	Yes	-	-	-	-
	Risk Management	-	Yes	-	-	-
	Requirements from the surroundings	-	Yes	-	Yes	-
	Preferred alternative	-	-	Yes	-	-
	BVP approach sessions	-	-	-	-	Yes

As one will be able to notice, only four activities were recognized by all respondents. As not all of the activities were recognized by all respondents this could imply that some of the recognized activities are role specific and not identified by other roles, or that this was not a typical early project phase project (as described by the respondents of the exploratory interviews). Nonetheless, all of the respondents were either in the core management team of the project are closely related to the team. This should indicate that they would agree on the same activities, as they all stated to have frequently consulted with each other during the duration of the project. Additionally, as the project management plan was split up into several smaller plans for each design loop within the early project phase an attempt was made in simplifying the project. Towards the end of the early project phase the project endured problems due to reorganizations with the client, which caused miscommunications and delays. This could be an explanation for some of the misperceptions in activities as the focus of the project changed to updating the new project members about the progress of the project and its current status.

Focusing on the activities recognized by all respondents, the assessment phase and problem analysis was divided up into the different design loops. The loops also consisted of scenario analysis. These loops have several similarities with agile iterations as they were all short term (approximately 2 months) and included the client to a certain extent. The daily stands and client involvement was limited to weekly updates and consults. Additionally the iterations, in this case referred to as loops, were not delivered to the client every 2-4 weeks. All respondents correspondingly replied that this period is too short for infrastructure. Certain documents can be delivered to the client within a month; however this is different to the rest of the project. The rest of the project cannot be delivered in such short amount of time.

Project Organization

Every respondent was asked to determine their project organization as well as explain everyone's role. The researcher made a sketch of the description after the first interview and correspondingly asked the other respondents if they would agree or if the organization was set up differently.



As the figure illustrates, the project organization consists of a core team level and cluster manager with teams under them. Everything communicated to the core team. The core team level also meets with the client regularly. The specialists in the teams (road design, underlying road network, and constructions) are not involved in this communication. All respondents were able to identify the core team; however several small differences existed in the rest of the project organization. Nevertheless, when the figure was shown to the project members, they all agreed upon the above figure. In total nearly a hundred employees booked hours for the project, and approximately thirty employees steadily worked on the project.

Value Measures Projects

Project Criteria Measured	**Method**	**Tool**
Costs	Forecasting, Performance Reviews	-
Timescale	Weekly stands, Gantt Chart, Lean Planning	-
Scope	Product Verification List	-
Quality	KPI's, report internal and external validation, interface management sessions, client sessions	-
Customer Satisfaction	Standard performance measures RWS, feedback sessions	-

Value Measures Project Processes

Process Criteria Measured	**Method**	**Tool**
Scheduling	Planning buffers, LEAN planning	Gantt Chart, Critical Path Method
Client + Stakeholder Satisfaction	Upfront KPI's, active engagement	Stakeholder mapping, balanced scorecard
Project Team	Project Start-Up – getting to know each other	-
Budgeting	Forecasting	Excel planned/actual costs
Performance Information	Openness to stakeholder and clients about project progress, progress reports	Completeness of requirements checks
Scope	Sub-PMP's, product lists	-
Risks	Weekly reports, risk sessions, RISMAN	-
Quality	Peer reviews, audits (SCB tests), warm transfer with the client	-
Managing change	Impact analysis	-

All of the project value measures were measured in this project and the value of each of the criteria performed as expected or better than expected in the project. This indicates that the current methods used are satisfactory for the value of projects. Aspects of agile that are included in the measurements of value for projects are the weekly stands (instead of daily), reviews and feedback sessions as well as the manner in which the timescale of the project is planned.
The process measures excluded three of the total amount of criteria concluded from literature. None of the respondents mentioned an explicit way in which this could be measured accordingly. Also, no other criteria were measured. Aspects of agile that are included in the measurements are the manner in which short term planning is completed, active engagement of the client and

stakeholders in order to ensure correct input-output, openness about the progress, audits, and impacts analysis with all involved parties.
The respondents stated not to see the need in measuring more criteria for the process, as the focus of this project was already primarily on the process. If one of the ways of measuring should still be improved more, it would be risk management.

Most evident reasoning for implementation of agile project management
None of the respondents were aware of the agile technique, although one of the respondents had heard of the methodology during a conference. Therefore no agile elements were intentionally involved in the project. Nonetheless the surveys and discussions about the agile elements have provided an overview of opportunities and drawbacks of agile in infrastructure projects. The discussions have been summed up in the following list:

Process:
- Evaluating after each project phase will be good for projects. However, evaluating after each delivery (for example each document sent to the client) will be unnecessary. The evaluations will then also lose their desired effects.
- Evaluating within smaller teams should be completed. However be careful with the amount of times you evaluate, as if you are evaluating too often people won't take the evaluation serious anymore.

Teams:
- The project organization is one big team but split up into multiple smaller teams. The project rooms really contributed to intense collaboration between sub teams. In order to prevent the process from becoming chaotic everyone had his/her own discipline but everyone was working together.
- Within the small sub-team face-to-face communication will be possible but as soon as the teams become bigger this will be more difficult and often also cost a lot of money.
- A type of hierarchical approach should always be applied in a project organization. This allows for clarity and people to fall back on their leader if they are unsure of decisions. It also keeps the project roles pure and allows people to focus on the things they are asked for in the project.

Planning:
- Daily stands are too often. Weekly stands are encouraged instead.

Project:
- You need to be flexible however you should not be accepting changes throughout the project. You are working towards goals and in order to achieve this you will need to stop accepting changes at a certain point. Hard deadlines need to be made for designs.

Documentation:
- Documentation should only be minimized for example for sub-PMP's. A lot of the project documentation need to be developed for legal reasons. This will not change in the future as we will always need to establish every detail of the project formally.
- Short term planning should only be made in combination with long term planning.

Clients:
- The client should not be involved at all times as specialists should be able to complete their work. The client will often also not have the knowledge to evaluate the specialist work. For example when a specialist is making their noise calculations it will not be necessary for the client to be physically be there.

Appendix C3: Extensive Results Case Study 3

Early Project Phase Activities

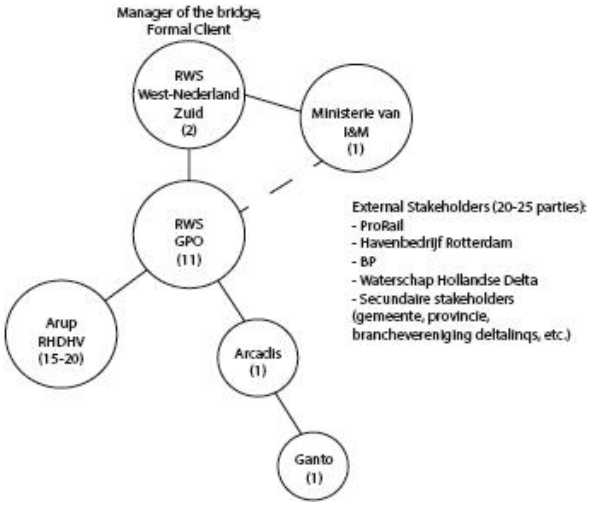
As also mentioned in the previous activities description, the summarized activities out of the exploratory interviews were given to the interviewees to evaluate in relation to the particular project for discussion. Interviewees were able to identify which activities were also performed in the particular project as well as identify additional activities.

		Respondents			
		10	11	12	13
Activities	Compose start document	-	-	-	-
	Assemble project organization	Yes	Yes	Yes	Yes
	Cost-Benefit Analysis	Yes	-	-	Yes
	Scenario Analysis	Yes	Yes	Yes	Yes
	Environmental Impact Report	-	-	-	-
	Problem Analysis	Yes	Yes	Yes	Yes
	Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes
	Decision-making phase (policy anchoring and preferential decision)	Yes	Yes	Yes	Yes
	Form of Contract	Yes	Yes	Yes	Yes
	Permit process	Yes	Yes	Yes	Yes
Add	Area research	Yes	-	-	-
	Actively involving parties	-	-	Yes	-

In total seven out of the ten activities collected during the exploratory interviews have been recognized coherently by the respondents. Half of the respondents mentioned that there were no extra activities engaged in in this project. The other half both mentioned one extra activity. However the area research is most likely also part of the problem analysis. Involving parties is one of the disciplines in the project considered extremely important, also due to the high number of stakeholders involved. Therefore this is certainly an important extra activity recognized by the third interviewee. Moreover, as most of the activities are recognized by all respondents even though the respondents are from two different disciplines as well as companies – this indicates that probably a lot of the other project team members will also be aware of the same activities. Therefore the coherence of the answers indicates that these activities are trustworthy to accept as the activities performed in the early project phase of this project.

Project Organization

All respondents were asked to describe the project organization and the amount of team members as well as their project roles. All respondents correspondingly drew up the following organizational chart along with the amount of employees involved in each discipline.



Furthermore estimates of forty to forty-five employees are highly involved in the project. Additionally the respondents recognized a considerable amount of external stakeholders involved. Again an estimate amount of stakeholders was provided, being twenty to twenty-five stakeholders.

Value Measures Projects

Project Criteria Measured	**Method**	**Tool**
Cost of the project	Forecasting, Value Engineering	SSK Estimate, SAP, Cost Management Plan
Quality	Evaluations	Value Engineering sessions, Issue management
Clients + Stakeholder Satisfaction	Emotional response to the outcome of the process	Value metrics, Value engineering

Value Measures Project Processes

Process Criteria Measured	**Method**	**Tool**
Scheduling	Milestone planning, plan boards	Weekly stand ups
Budgeting	Cost forecasting	Activity based costing
Scope	Scope statement, Clarity of goals, requirements list	Product Breakdown Structure, Work Breakdown Structure

A striking result from one of the respondents was that nothing in the project or process was being measured, at least explicitly. The respondent identified to being reluctant to measuring during projects. The respondent stated that when not measuring often you are stricter for the project than when something is made explicit. The other respondents almost coherently measured the same criteria in the process and for the project. For any additional criterion one of the respondents mentioned to want to measure integral safety throughout the project process. This is related to a range of safety elements such as social security on the work floor and occupational safety. There is an urge to measure this because this project will need to be completed in a very short amount of time – which often establishes a rush and could lead to dangerous situations. However, this criterion is related more to the execution phase of the project, rather than the early project phase.

Furthermore all respondents stated that value for the client is most important. One of the respondents stated that the value personally and for the company is subordinate to the value for the client. The respondents agreed on a balance ratio of 70 percent focus on the client and 30 percent focus on value delivery for the company.

One of the respondents identified to not have measured much during the project due to the structure of the project which didn't allow for measurements. The basic process was measured through evaluations that included conclusions regarding improvements but a retrospect specifically to the mentioned criteria was not performed. Within a well-considered set-up (that should be drafted in the beginning) these measuring tools should be incorporated. If more criterions were to be measured the respondents have agreed on risk management as this also allows for an indication of opportunities that can be used to guide the project. Moreover individual attitudes will be important as during high time-pressure people often tend to fall back into their natural habitats and execute a project in a traditional manner in which they feel comfortable even though the objective is to work differently.
Furthermore drawbacks in current value delivery and opportunities to be able to deliver more value in projects were discussed with the interviewees. Likewise, the results of the interviews have been summarized into statements with a short explanation below.

Most evident reasoning for implementation of agile project management
All of the respondents mentioned to be familiar with agile project management. For all this was the first project in which they applied scrum aspects. Scrum was applied for the decision document at the end of 2016. They worked on this document with a small but multidisciplinary team. Additionally they work in short sprints (6 weeks) and submitted several versions of the document whilst asking the decision makers for feedback on each version. The respondents all considered scrum to be the methodology used when applying agile project management. Moreover the respondents mention to have used aspects of agile, but never having completed a full agile project.

In order to identify possible opportunities for agile project management in the infrastructure industry, the survey results were discussed with the interviewees. Elements which they did not recognize in projects but found extremely important, elements which they did recognize but did not find important, elements which they did not recognize and also didn't find important, as well as elements which were recognized and also important were discussed. Below the most important results of the discussions are displayed, ordered in the themes as provided in the survey as well.

Deliveries:
- Design cycles were established for six weeks however this did not mean that we always delivered to the client after those six weeks. The deliveries do not always mean something to the client, thereby making it unnecessary to always deliver to the client after six weeks. The deliveries can also be internally.
- We did have sub-deliveries but definitely not every 4 weeks. Conscious deliveries are not a way of working we are used to. The cycles of 6 weeks are to serve as milestones for the project team but not to always to also deliver to the client. They are internal deliveries, but also not standard every 4 weeks. This really depends on the phase of the project. The deliveries are not regularly organized.

Process:
- An iterative process should be applied to projects; however frequent deliveries will be difficult and not always possible. Deliveries should be completed when necessary.
- Evaluating after deliveries is not something we regularly do. It would be better to start doing this more regularly.

Planning:
- Haven't experienced revising activities are reprioritizing them. In the project the team does work towards an end goal and they do discuss if everyone is still working towards the correct goal. However, the team is not used to reprioritize and to see the changes also in the bigger picture of the entire planning. This would be something to try out.

Teams:
- Daily stands are almost always unnecessary. However, weekly stands on a regular basis could work, depending on everyone's availability. This also depends on the size of the project. In any case make sure that the stand-up meeting is only organized when relevant.

- Cross-functional teams provide potential for the project. Multifunctional professionals will have the ability to come up with solutions by themselves and be able to discuss these solutions in close collaboration.
- Progress meetings are organized almost weekly. However, evaluation sessions are rarely organized. It would be better to organize this more often.
- The amount of changes and the pace in projects is very high making it difficult to predict which information is relevant to whom. If you spread too much information then people will lose track of the progress and new information and create chaos. An appropriate balance should be found.
- Spreading updates within the team and with other teams is often a weakness and becomes chaotic. This should be not more appropriately.

Project:

- The project has been simplified into shorter design cycles of 6 weeks. However, in experience if the project is made simpler people will find a way to make it more complex because this is the way they are used to work. Especially with specialists.

Clients:

- It will simply be irrelevant to include the client at all times. The client will often not have the knowledge, time, or interest to be included in every step along the way. For example, the client will not be interested in getting an update of every small change in a calculation. Instead they will be interested in the final calculations.
- It is difficult to continuously ask the client for reviews as there will be a lot of products to be delivered in each project. You will need to find the appropriate balance for reviews. Nonetheless, the evaluations are extremely important, and the client should be involved properly. This will help to continuously check if the team is still working on the correct track.
- The clients should only work on location when this also benefits them. In the case of value engineering sessions they were always included, as it was important to also include their opinions and requirements in the project.
- The client will not need to be included in planning sessions at all times. This should be done occasionally but not on a regular basis each week. Maybe it can be good to involve the client regularly but this might be a traditional believe. At the start of a phase should be enough.

Documentation:

- There should be a balance. By only planning for the short term of the project, one will not keep in mind the long term planning. Both should be completed. However, you should always try to stick to the planning established upfront. Next to this, short iterations can be performed for the near future.
- Minimizing documents should not always be performed as certain things should be documented properly in for example the PMP. These documents can be leaner but they should still at least be described. Especially in a large project proper documentation management should be provided. Maybe a documentation-sharing platform can be a solution instead of minimizing documentation at all times.

Location:

- The project room wasn't large enough to allow everyone to work on-site. However, from experience this would be better if more often teams work together on-site (better teamwork, communication, spreading of updates).

Appendix C4: Extensive Results Case Study 4

Early Project Phase Activities

In order to understand the project more clearly, the activities performed in the early project phase have been discussed during the interviews. During the exploratory interviews several activities were collected and have been presented during the case study interviews. The interviewees were asked to identify which activities were also performed during this project, and if they could think of any extra activities that belong to this phase of the project.

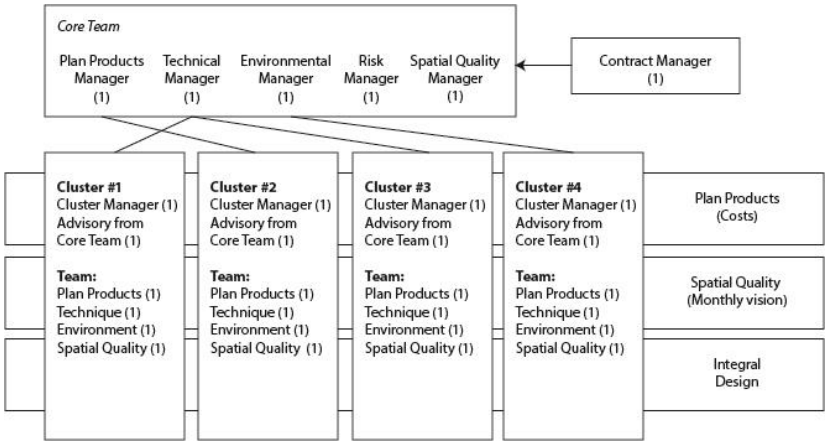
		Respondents			
		14	15	16	17
Activities	Compose start document	Yes	Yes	-	Yes
	Assemble project organization	Yes	Yes	Yes	Yes
	Cost-Benefit Analysis	-	-	-	-
	Scenario Analysis	Yes	Yes	Yes	Yes
	Environmental Impact Report	Yes	Yes	Yes	Yes
	Problem Analysis	-	Yes	Yes	Yes
	Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes
	Decision-making phase (policy anchoring and preferential decision)	Yes	Yes	Yes	Yes
	Form of Contract	-	Yes	-	Yes
	Permit process	Yes	-	Yes	Yes
Additional	Determine system regulations	Yes	-	-	-
	Stakeholder analysis	-	Yes	-	-
	Costs of variants	-	Yes	-	-
	Spatial Quality Analysis	-	Yes	-	-
	Client requirements	-	-	Yes	-

In total the interviewees coherently viewed five out of the ten activities to belong to the early project phase of this project. The different opinions on the activities belonging to the early project phase could be due to the size of the project. Half of the respondents interviewed were a cluster manager and were responsible for all the disciplines for 3-4 dike reinforcements and a team designing these reinforcements. The other half was part of the core team and guided these cluster managers and teams throughout the project. However, even for the two core team members, their ideas on activities engaged on during this project differs. The cluster managers have explained that within their own cluster team they are able to apply their own management approach and the designs of the dike reinforcements and other disciplines are only checked through integral sessions with the other clusters. As the project is not yet completed, it could be that some of the respondents are further along in the project and have experienced other activities than the rest. An example of the different approaches is found in visual management and the weekly stand ups. This management approach was passed on from the core team during a planning session. However, half of the cluster teams considered this to be less useful (either due to inexperience with the boards or habits of working in a different manner) and stopped applying this approach with their teams soon after the session. Up to now no obligation to reapply the visual boards and weekly stands have been imposed by the core team. Thereby indicating that it is accepted that each cluster team is managed differently. However, this also questions the information flow throughout the project.

Furthermore, also from the interview results, there seems to be a type of chaos in the project due to the time pressure, size and combination of two companies. This most likely the logical explanation of why the different respondents also considered different activities in the project.

Project Organization

All respondents were asked to describe the project organization. Probably due to the size of the project, the interviewees provided a somewhat different organization. The project roles were all provided, however the way the roles were organized was slightly different for each respondent.



Also during the explanation of the responsibilities within the cluster teams and which products were applicable to all clusters and which role was responsible for this, seemed to be slightly differently explained by all respondents. Altogether, the main outcomes of the project organization descriptions have been displayed in the figure above.

Value Measures Projects

Project Criteria Measured	**Method**	**Tool**
Cost of a project	Forecasting, efficiency of project	Earned Value Analysis
Timescale	Determining upfront how much time you need	Schedule Performance Index
Scope	Work package description	List of products, percentage of completion
Quality	Plan & Define requirements achieved, verification models	
Client + Stakeholder Satisfaction	Response to the project outcome	

Value Measures Project Processes

Process Criteria Measured	**Method**	**Tool**
Scheduling	Lean planning, Weekly stands	Gantt Chart, Critical Path Method, Milestone Prediction Chart
Budgeting	Cost forecasting	Earned Value Analysis, Planned/Actual Costs in Excel
Performance Information		Completeness of requirements
Scope	Scope statement, clarity of goals, relatics	Contract breakdown structure, product breakdown structure, work breakdown structure
Communication	Project Management Plan, Formal reports, Newsletter	Peer Reviews, Weekly Stand-Up Meeting
Risks	Identifying risks, risk sessions	Risk Management Plan, Risk Register, Risk Impact Assessment

For the project value criteria four out of the five criterions were measured. This is quite a considerable amount. Additionally, up till now all criteria have scored satisfactory, as expected. For the process criteria, six out of the twelve criteria were measured. Noticeable is that during

the interviews the respondents mentioned that it was very important for the project to continuously include the project environment and collect requirements from the residents living in the area, as well as update them at set times. However, when asking the respondents if they measured client and stakeholder satisfaction levels and scope during the process of the project, none of the respondents referred to this.

Additionally the respondents were asked if they measured any additional criterion for both the project and the process. Coherently all respondents replied that they did not measure any additional criterion and that this list covered the most important criterion to be measured in projects and processes.

Furthermore, the respondents were asked if they would like to measure any of the criterions which are currently not measured, and if this would make a considerable difference to the performance of the process and project. All respondents recognized to finding it important to start measuring interim client and stakeholder satisfaction. Two of the respondents also answered to finding it important to measure the project teams (measuring if the members are of the right quality as well as the teamwork).

The focus ratio between value for the client and value for the company was considered to be 50-50 by all respondents. The value of the company is found in bringing in knowledge and value for the client is delivering a satisfying project meets the requirements.
The last part of the interview regarding the value management section asked the respondents if they could identify and drawbacks in value delivery in current practices as well as opportunities. These results have been summarized in the statements below.

Most evident reasoning for implementation of agile project management
Two of the respondents mentioned to have heard about agile project management and also applied it in a previous project where they focused on working more effectively and efficient. Another respondent answered to be familiar with agile project management in the sense of implementing methodologies that focus on good interface management. Only one of the respondents was unfamiliar with agile project management. In order to identify which possible agile elements are already being applied in infrastructure projects and which agile elements could potentially add value to projects and processes, the section below will discuss some of the survey results of the interviewees. Mostly the following results were discussed: if an agile element wasn't experienced in the project but the respondent would really want to experience it, or if an agile element was experienced but the respondent didn't want to experience it, if an element was experienced and the also really wanted to keep this in projects, as well as if something wasn't experienced and the respondent agreed to not needing this in projects. The discussions have been organized into the themes as found in the survey.

Process:

- You need to find a balance when a product should be evaluated and when it should not, as there are so many products within the project that the client will likely become less motivated to fill in each evaluation and a lot of time will need to be spent on this.

Teams:

- Daily stands are too much for the general project progress. The project will take up a few years. Therefore stand ups every two weeks will be enough. Sometimes, during busy periods with critical milestones, once a week will be better.
- For personal documents updates are known, however for updates and information flow for the entire project, a lot can still be learned. Often there are many different versions of reports and people are unsure which version they should use.
- Team evaluations tend to be informal. It would be better if these were organized on a regular basis as well as in a formal manner.

Clients:

- Include the client during planning sessions, but limit this to the start of every phase. Added value is almost always achieved when the client is invited. Our planning sessions often change in our agenda's which makes it difficult to communicate to the client when the planning sessions will take place.

Documentation:

- Planning should not only be completed for the short-term, as you have a final goal that you are trying to achieve and you are working towards this. Of course you need some sort of day-to-day planning but you should never lose the end result out of sight. The day-to-day planning will always be related to the main outline of the project. This can never be viewed separately or disregarded.
- You cannot minimize all documentation. You need to find a balance in this. Per project you need to see how much you are going to write and which aspects can be left out. However it would be nice to only document the necessary and not keep producing extreme long reports.

Location:

- Color coding should be completed more appropriately. There was no structure in out planning which confused many people. Therefore also during the planning sessions the schedule updates became chaotic.
- We did not have a project room where we could hang up project documents such as the project planning per team. This should be improved, as fixed locations to work are considered useful.
- The workplaces for this project are very bad. Open workplaces would be better and would enable project members to more easily work together.

Appendix C5: Extensive Results Case Study 5

Early Project Phase Activities

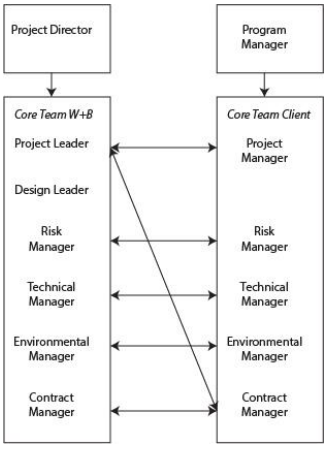
During the interview, the respondents were asked to define the activities which took place during the early project phase of this particular case study. As during the exploratory interviews respondents already provided a list of activities, that list of activities was provided during the interviews.

		Respondents				
		18	19	20	21	22
Activities	Compose start document	Yes	Yes	Yes	Yes	Yes
	Assemble project organization	Yes	Yes	Yes	Yes	Yes
	Cost-Benefit Analysis	Yes	Yes	Yes	Yes	Yes
	Scenario Analysis	Yes	Yes	Yes	Yes	Yes
	Environmental Impact Report	Yes	Yes	Yes	Yes	Yes
	Problem Analysis	-	Yes	Yes	Yes	Yes
	Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes	Yes
	Decision-making phase (policy anchoring and preferential decision)	Yes	Yes	Yes	Yes	Yes
	Form of Contract	Yes	Yes	Yes	Yes	Yes
	Permit process	Yes	Yes	Yes	-	Yes
Additional?	Process environment	-	Yes	Yes	-	-
	Stakeholder Analysis	-	-	Yes	-	-
	Client Requirements	-	-	Yes	Yes	-
	Environment information	-	-	Yes	-	-
	Safety Requirements	-	-	-	Yes	-
	Communication plan	-	-	-	Yes	-
	Risk Management	-	-	-	-	Yes

As the list illustrates, eight out of the ten activities as mentioned during the exploratory interviews took place in the early project phase of this case study. For the remaining two activities one respondent disagreed for each activity. All of the respondents were part of the core team, which probably explains why most of them agree on all of the activities.

Project Organization

During the interviews, each respondent was asked to describe the project organization and everyone's role within the project. All the respondents described the project organization the same was, which is illustrated in the figure below.



As described in the project management methodology section above, the IPM roles were used to define the core team of the project. The team also had a counter team of the client. In total approximately fifteen employees were actively involved in the project.

Value Measures Projects

Project Criteria Measured	**Method**	**Tool**
Cost of a project	Forecasting, performance reviews	BST10
Timescale	Lean planning, Project duration review	Weekly stands
Quality	Plan of Approach	
Client + Stakeholder Satisfaction	Emotional response to outcome	Product acceptance check

Value Measures Project Processes

Process Criteria Measured	**Method**	**Tool**
Scheduling	Lean planning, time buffers	MS Project, Critical Path Method, Milestone prediction chart
Client + Stakeholder Satisfaction	Progress meetings	Stakeholder mapping
Budgeting	Cost Forecasting, progress reports	BST10, Activity Based Costing, Earned Value Analysis, Planned/Actual Costs
Risk	RISMAN, identifying risks	Risk Register
Quality	ISO 9001 Quality Management, Quality Plan, KES	Quality Assurance
Managing changes	Track changes	Lean sessions

In total four out of the five criteria as collected in the literature study were measured for the value of projects. For the value of the project process, six out of the twelve criteria were measured. When the respondents were asked if any criterion was missing, they correspondingly replied that this was the complete list of what was being measured and that they could also not think of any more criterion too add to the list they were provided with.

The respondents were then asked if they thought any of the criteria not measured currently should be measured and could have an impact on the project and process. Four out of the five respondents responded that they didn't think it would be necessary to measure more in a project or a process. Only one of the respondents found it important to also measure the project teams. Evaluate what went well and what should change as well as internal project member satisfaction. Furthermore, the respondents identified a difference in value delivery for the client and for the company. Nonetheless the overall focus should be 50-50. One of the respondents added that if the project team is able to deliver more value to the client within the project, then it will also be valuable to the company. On the other hand another respondent added that in the end the company also wants to be paid or make profits out of the projects. In the end the client's request should be fulfilled as much as possible, since that is what the client hired W+B for. Apart from the financial balance, it will be important to develop a long term relationship with the client (for example if the project is nog satisfactory but we do have a good relationship with the client – there is a good chance we will continue working with the client in the future).

The following part on value management of the interview asked the respondents if they could come up with certain drawbacks of current value delivery as well as opportunities. These results have been summarized in statements below followed by a short explanation.

Most evident reasoning for implementation of agile project management
All respondents have coherently explained that they are unaware of agile project management and have also never used it in a project. The respondents were given the survey prior to the interview in order to start to think about experiences with the agile elements as presented in the survey document, in current practices. At the end of the interviews, some of the answers of the interviewees were discussed. For example if an agile element wasn't experienced in the project but the respondent would really want to experience it, or if an agile element was experienced but

the respondent didn't want to experience it, if an element was experienced and the also really wanted to keep this in projects, as well as if something wasn't experienced and the respondent agreed to not needing this in projects. The discussions have been organized into the themes as found in the survey.

Process:

- Evaluations after deliveries are rarely experienced but should be completed more often. Project teams should always check if the products delivered are also correct. Additionally evaluations should be completed throughout the project, not only the final version of products.

Teams:

- Smaller teams within the project work well. The smaller teams are more efficient and the communication is better. Additionally, working towards the same goals is perceived to be easier in smaller teams.
- A daily stand is too much in the project process as you will need to allow people to also complete individual tasks. An update daily will simply be a waste. Instead weekly will be enough. Often the different disciplines work together once a week at the company and once a week at the company and one day a week at the client. However, the stands must only be organized in the right period of the project phase.
- Spreading updates and information should not be done continuously. Weekly stands and newsletters are enough sources to spread the most important information. You should keep updates and information spread limited to this to keep everyone calm and allow people to work on their own tasks and deliveries. Also it depends on the tasks.
- Regularly evaluating within and outside of the team is rarely experienced but should be completed more often. People are often used to speeding up especially when a deadline is on its way. However it would be better to take more time to evaluate and discuss what has already been accomplished – how this went, what can be done better next time, and what should stay the same in the next phase.

Project:

- A project should not continuously be open to changes. Some changes are good but continuously accepting the changes will not work. At a certain point in the project the project team will need to say stop and not accept any more changes. In-between phases accepting changes will be fine, however once involved in a phase you should complete the products and not accept changes that will change the product again (between design loops accept, within reject).

Documentation:

- Only planning on for the short term period of the project will be insufficient. The long term planning should also be included.
- The short term was displayed using lean planning in order to everyone to understand what is to be completed in the near future. Hereby everyone will feel more included and aware of the common goals of the project. Planning ahead for approximately 1-2 months will be enough.

Appendix C6: Extensive Results Cross Case Analysis

Early Project Phase Activities

In the individual case study results chapter, an overview has been provided for the activities each project engaged in. The table below provides an overview of all of these individual case study results. The additional activities for each case study have been left out as all of the mentioned extra activities were very different per case study.

	Case study				
Activities	**1**	**2**	**3**	**4**	**5**
Compose start document	Yes	-	-	-	Yes
Assemble project organization	Yes	Yes	Yes	Yes	Yes
Cost-Benefit Analysis	-	-	-	-	Yes
Scenario Analysis	Yes	Yes	Yes	Yes	Yes
Environmental Impact Report	Yes	-	-	Yes	Yes
Problem Analysis	Yes	Yes	Yes	-	-
Assessment phase (choosing alternatives)	Yes	Yes	Yes	Yes	Yes
Decision-making phase (policy anchoring and preferential decision)	Yes	-	Yes	Yes	Yes
Form of Contract	-	-	Yes	-	Yes
Permit process	Yes	-	Yes	-	-

Out of the ten different activities collected during the exploratory interviews, three activities were recognized by all respondents and in all case studies, namely: assemble a project organization, scenario analysis, and assessment phase where an alternative is chosen. All of the other activities weren't coherently recognized by the different respondents. The first activity, composing a start document, was only recognized by the first and fifth case study. However, these case studies vary in every project characteristic except for the project type and project management plan approach. As one other case study also has these characteristics, but does not recognize this activity, a pattern for project use for this activity lacks.

Noteworthy for the fifth case study is that it is the only project that recently started, and also the only project to recognize a cost-benefit analysis in the early project phase. As this project is also the shortest, with the smallest team size, and least amount of external parties, this could be a reason for implementing this activity.

Next, the environmental impact report was only recognized by the dike projects. This implies that this activity is only relevant to a particular type of project, and does not necessarily depend on other project characteristics.

The problem analysis was completed by the finished projects that also had the longest duration (more than two years). It could be that the problem analysis is only completed at the end of the project (as the other two are not yet complete), however this seems very unlikely. Another explanation for recognition of the activity in the first three case studies is that a problem analysis is only performed in projects that have an early project phase longer than two years. The next activity, decision-making phase, was recognized by each case study except for the second. The second case study was the only case study with a different project management plan approach, namely a short document for each phase of the project. Additionally, the case study was the only project that applied a best value approach, whereby valuable solutions and opportunities were already mentioned upfront. Both these methods could be an explanation for not engaging in the preferential during the project.

For the form of contract, the third and fifth cases recognized this activity. However, as the third project seems to be at least double of what the fifth project is – duration, team size, and external parties – no particular link is found between the projects that explain this activity.
The last activity is the permit process which was recognized by the first and third case study. As both projects had the most external parties, this could be an explanation for why the permit process was established, as well as the environment in which the project was located.

Appendix D1: Correlation Analysis Main Tables

Abb.	Correlation Analysis PROJECT VALUE SPSS Spearman's Rho (Two-tailed)		VPrj_01 Value of project costs	VPrj_02 Value of project time	VPrj_03 Value of project scope	VPrj_04 Value of project quality	VPrj_05 Value of project client satisfaction
LE1	Early and frequent delivery every 4 weeks	Corr. Coefficient	0,164	**0,274***	**0,341****	**0,275****	0,112
		Sig. (2-tailed)	0,130	0,010	0,001	0,010	0,259
		N	87	87	87	87	87
LE2	Track project deliveries continuously	Corr. Coefficient	0,066	0,044	0,199	-0,068	-0,079
		Sig. (2-tailed)	0,543	0,689	0,065	0,533	0,467
		N	87	87	87	87	87
PR1	Focus on frequent delivery through an iterative process	Corr. Coefficient	0,059	0,109	0,162	0,009	-0,052
		Sig. (2-tailed)	0,585	0,316	0,135	0,937	0,634
		N	87	87	87	87	87
PR2	Evolutionary development that aims to continuously improve	Corr. Coefficient	**0,228***	0,191	**0,465****	0,210	0,195
		Sig. (2-tailed)	0,034	0,076	0,000	0,051	0,071
		N	87	87	87	87	87
PR3	Evaluations after each timebox	Corr. Coefficient	-0,089	-0,085	-0,057	-0,063	-0,095
		Sig. (2-tailed)	0,410	0,434	0,601	0,561	0,379
		N	87	87	87	87	87
PR4	Modify aims and planning when changes occur	Corr. Coefficient	0,129	-0,089	-0,077	-0,057	0,018
		Sig. (2-tailed)	0,234	0,410	0,479	0,601	0,867
		N	87	87	87	87	87
PL1	Change is welcome even in later phases of the project development	Corr. Coefficient	0,133	0,074	-0,042	0,063	0,029
		Sig. (2-tailed)	0,218	0,494	0,699	0,564	0,787
		N	87	87	87	87	87
PL2	Apply daily stands to regulate the project planning	Corr. Coefficient	0,036	0,124	-0,150	-0,147	-0,111
		Sig. (2-tailed)	0,744	0,252	0,164	0,174	0,307
		N	87	87	87	87	87
PL3	Integral planning sessions are applied to encourage interfaces	Corr. Coefficient	**0,238***	0,137	-0,034	-0,038	0,102
		Sig. (2-tailed)	0,026	0,204	0,757	0,728	0,347
		N	87	87	87	87	87
PL4	Regularly revise original planning and re-prioritize activities	Corr. Coefficient	0,075	-0,065	0,01	0,067	0,172
		Sig. (2-tailed)	0,488	0,547	0,925	0,538	0,112
		N	87	87	87	87	87
TE1	The project is organized into more small teams instead of one large team	Corr. Coefficient	-0,081	0,204	0,155	-0,005	0,048
		Sig. (2-tailed)	0,454	0,058	0,153	0,963	0,661
		N	87	87	87	87	87
TE2	Self-management' attitude of teams	Corr. Coefficient	-0,062	0,135	**0,263***	0,192	**0,221***
		Sig. (2-tailed)	0,565	0,212	0,014	0,075	0,040
		N	87	87	87	87	87
TE3	Cross-functional teams	Corr. Coefficient	0,137	-0,033	0,099	-0,043	-0,034
		Sig. (2-tailed)	0,206	0,764	0,36	0,691	0,755
		N	87	87	87	87	87

TE4	Teams work at the same location	Corr. Coefficient	-0,100	-0,025	0,029	-0,032	0,084
		Sig. (2-tailed)	0,357	0,816	0,786	0,770	0,44
		N	87	87	87	87	87
TE5	Face-to-face meetings are organized as much as possible (instead of emailing/skype)	Corr. Coefficient	-0,040	-0,077	**0,242***	0,003	0,099
		Sig. (2-tailed)	0,71	0,478	0,024	0,977	0,362
		N	87	87	87	87	87
TE6	Within the team as well as with other teams - daily stands are often organized	Corr. Coefficient	0,115	-0,045	0,102	0,011	0,017
		Sig. (2-tailed)	0,289	0,676	0,347	0,923	0,874
		N	87	87	87	87	87
TE7	Information and updates are always spread throughout the project team	Corr. Coefficient	0,116	0,007	0,157	0,079	0,115
		Sig. (2-tailed)	0,286	0,945	0,146	0,468	0,288
		N	87	87	87	87	87
TE8	Evaluation sessions with the team are regularly organized	Corr. Coefficient	0,08	0,053	0,168	0,053	0,17
		Sig. (2-tailed)	0,46	0,064	0,119	0,0624	0,116
		N	87	87	87	87	87
TE9	Encourage a good collaboration with all teams	Corr. Coefficient	0,144	0,036	**0,250***	0,117	**0,227***
		Sig. (2-tailed)	0,182	0,737	0,020	0,279	0,034
		N	87	87	87	87	87
PJ1	Always be open to changes in the project	Corr. Coefficient	-0,039	-0,062	0,184	-0,134	0,012
		Sig. (2-tailed)	0,721	0,566	0,088	0,217	0,916
		N	87	87	87	87	87
PJ2	Throughout the project continuously focus on improving	Corr. Coefficient	0,14	0,108	**0,226***	0,141	0,193
		Sig. (2-tailed)	0,197	0,318	0,035	0,192	0,073
		N	87	87	87	87	87
PJ3	Divide the project up into smaller do-able projects	Corr. Coefficient	-0,054	-0,054	0,141	0,149	0,013
		Sig. (2-tailed)	0,621	0,618	0,192	0,169	0,905
		N	87	87	87	87	87
PJ4	Simplify the project by completing several smaller projects	Corr. Coefficient	0,222*	0,143	0,201	0,012	0,031
		Sig. (2-tailed)	0,039	0,186	0,012	0,91	0,774
		N	87	87	87	87	87
KL1	The client is involved in each step to be completed in the project process	Corr. Coefficient	0,084	0,003	0,159	0,008	0,127
		Sig. (2-tailed)	0,438	0,978	0,14	0,943	0,241
		N	87	87	87	87	87
KL2	The client is involved with planning sessions	Corr. Coefficient	-0,105	-0,085	-0,015	-0,041	-0,045
		Sig. (2-tailed)	0,332	0,434	0,889	0,706	0,679
		N	87	87	87	87	87
KL3	The client is involved with evaluation sessions	Corr. Coefficient	-0,047	0,032	0,070	0,164	-0,042
		Sig. (2-tailed)	0,667	0,770	0,519	0,128	0,701
		N	87	87	87	87	87
KL4	The client also works at the same location at the project teams	Corr. Coefficient	-0,043	0,118	0,080	-0,123	0,074
		Sig. (2-tailed)	0,693	0,278	0,459	0,256	0,493
		N	87	87	87	87	87
KL5	The collaboration with the client is highly important	Corr. Coefficient	0,179	0,091	0,199	0,135	0,196
		Sig. (2-tailed)	0,097	0,402	0,064	0,211	0,069
		N	87	87	87	87	87
ME1	The project evolves around motivated people	Corr. Coefficient	0,013	-0,031	**0,213***	**0,234***	0,167
		Sig. (2-tailed)	0,903	0,775	0,048	0,029	0,123

		N	87	87	87	87	87
ME2	Employees trust each other	Corr. Coefficient	-0,042	0,016	0,167	0,094	0,146
		Sig. (2-tailed)	0,700	0,88	0,123	0,386	0,178
		N	87	87	87	87	87
ME3	Employees help each other	Corr. Coefficient	0,047	0,007	0,113	0,085	0,188
		Sig. (2-tailed)	0,669	0,951	0,298	0,435	0,081
		N	87	87	87	87	87
DO1	Avoid long and detailed reports	Corr. Coefficient	0,016	0,142	0,166	**0,231***	**0,478****
		Sig. (2-tailed)	0,882	0,188	0,124	0,031	0,000
		N	87	87	87	87	87
DO2	Only plan for the short-term of the project	Corr. Coefficient	**(-)0,240***	-0,152	0,009	-0,028	0,149
		Sig. (2-tailed)	0,250	0,160	0,933	0,800	0,170
		N	87	87	87	87	87
DO3	Minimalize documentation	Corr. Coefficient	0,081	-0,017	0,037	0,074	**0,374****
		Sig. (2-tailed)	0,455	0,879	0,735	0,498	0,000
		N	87	87	87	87	87
LO1	All involved parties work at the same location throughout the project	Corr. Coefficient	-0,027	0,011	-0,042	-0,118	-0,039
		Sig. (2-tailed)	0,804	0,919	0,700	0,274	0,720
		N	87	87	87	87	87
LO2	Open workplaces encourage collaboration	Corr. Coefficient	0,003	-0,061	0,172	0,014	0,014
		Sig. (2-tailed)	0,977	0,577	0,111	0,898	0,895
		N	87	87	87	87	87
LO3	Project rooms for the entire length of the project (e.g. to hang the planning there)	Corr. Coefficient	0,046	-0,027	0,097	-0,003	-0,127
		Sig. (2-tailed)	0,674	0,802	0,371	0,975	0,242
		N	87	87	87	87	87
LO4	Use color-coding for documents hanging in project rooms	Corr. Coefficient	-0,011	-0,084	0,022	-0,033	0,011
		Sig. (2-tailed)	0,922	0,437	0,839	0,762	0,922
		N	87	87	87	87	87

Abb.			VPs_01	VPs_02	VPs_03	VPs_04	VPs_05	VPs_06	VPs_07	VPs_08	VPs_09	VPs_10	VPs_11	VPs_12
	Correlation Analysis PROCESS VALUE SPSS Spearman's Rho (Two-tailed)		Value of process planning	Value of process interim client and stakeholder satisfaction	Value of process team work	Value of process budget per phase	Value of process performance information	Value of process resources	Value of process scope	Value of process communication	Value of process risk management	Value of process quality	Value of process individual mentality	Value of process change management
LE1	Early and frequent delivery every 4 weeks	Corr. Coefficient	**0,242***	0,145	0,153	0,027	0,107	-0,028	0,101	0,096	-0,137	0,148	0,120	0,190
		Sig. (2-tailed)	0,024	0,181	0,158	0,804	0,324	0,800	0,350	0,377	0,207	0,172	0,268	0,078
		N	87	87	87	87	87	87	87	87	87	87	87	87
LE2	Track project deliveries continuously	Corr. Coefficient	0,210	0,164	0,210	**0,255***	-0,104	0,062	0,001	0,159	0,026	-0,162	**0,268***	0,107
		Sig. (2-tailed)	0,051	0,130	0,051	0,017	0,340	0,567	0,996	0,141	0,810	0,134	0,012	0,326
		N	87	87	87	87	87	87	87	87	87	87	87	87
PR1	Focus on frequent delivery through an iterative process	Corr. Coefficient	0,179	0,171	0,184	0,204	**0,247***	0,082	0,013	**0,241***	0,036	-0,079	0,189	0,126
		Sig. (2-tailed)	0,096	0,114	0,088	0,058	0,021	0,013	0,902	0,025	0,742	0,468	0,079	0,244
		N	87	87	87	87	87	87	87	87	87	87	87	87
PR2	Evolutionary development that aims to continuously improve	Corr. Coefficient	**0,264***	**0,230***	**0,311****	0,102	0,136	0,147	0,073	0,155	0,141	0,194	**0,227***	**0,273***
		Sig. (2-tailed)	0,013	0,032	0,003	0,345	0,209	0,175	0,504	0,151	0,193	0,072	0,034	0,010
		N	87	87	87	87	87	87	87	87	87	87	87	87

PR3	Evaluations after each timebox	Corr. Coefficient	0,007	0,008	0,057	17,000	0,125	0,117	0,046	0,208	0,059	-0,047	0,077	0,036
		Sig. (2-tailed)	0,945	0,94	0,598	0,876	0,247	0,281	0,675	0,053	0,585	0,663	0,480	0,739
		N	87	87	87	87	87	87	87	87	87	87	87	87
PR4	Modify aims and planning when changes occur	Corr. Coefficient	0,099	0,190	0,134	**0,226***	0,204	0,177	0,053	**0,306****	0,201	-0,122	0,050	0,069
		Sig. (2-tailed)	0,361	0,077	0,216	0,035	0,058	0,101	0,627	0,004	0,062	0,258	0,643	0,527
		N	87	87	87	87	87	87	87	87	87	87	87	87
PL1	Change is welcome even in later phases of the project development	Corr. Coefficient	-0,032	0,122	0,038	0,120	0,018	0,077	0,030	0,011	-0,163	0,128	-0,106	0,130
		Sig. (2-tailed)	0,770	0,261	0,726	0,268	0,865	0,477	0,785	0,922	0,133	0,238	0,330	0,228
		N	87	87	87	87	87	87	87	87	87	87	87	87
PL2	Apply daily stands to regulate the project planning	Corr. Coefficient	0,038	0,003	0,155	0,099	0,058	-0,104	-0,203	0,023	0,049	-0,188	0,058	-0,005
		Sig. (2-tailed)	0,727	0,975	0,151	0,364	0,592	0,337	0,060	0,829	0,652	0,081	0,596	0,965
		N	87	87	87	87	87	87	87	87	87	87	87	87
PL3	Integral planning sessions are applied to encourage interfaces	Corr. Coefficient	0,015	0,081	0,096	0,176	0,110	-0,099	-0,051	**0,246***	0,045	-0,047	-0,088	-0,022
		Sig. (2-tailed)	0,982	0,465	0,374	0,103	0,309	0,361	0,638	0,022	0,676	0,668	0,419	0,838
		N	87	87	87	87	87	87	87	87	87	87	87	87
PL4	Regularly revise original planning and re-prioritize activities	Corr. Coefficient	0,1	0,129	0,154	0,062	**0,285****	0,087	0,090	**0,270***	-0,180	-0,007	0,017	-0,042
		Sig. (2-tailed)	0,358	0,233	0,155	0,570	0,007	0,425	0,407	0,012	0,095	0,948	0,878	0,699
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE1	The project is organized into more small teams instead of one large team	Corr. Coefficient	0,136	0,078	0,059	-0,094	-0,047	**(-)0,214***	0,061	-0,074	-0,188	-0,015	-0,139	0,057
		Sig. (2-tailed)	0,211	0,473	0,585	0,388	0,663	0,046	0,576	0,493	0,081	0,891	0,200	0,603
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE2	Self-management' attitude of teams	Corr. Coefficient	0,130	0,160	**0,266***	-0,125	0,056	0,146	-0,004	-0,023	-0,080	0,098	**0,278****	**0,340****
		Sig. (2-tailed)	0,231	0,140	0,013	0,248	0,605	0,177	0,970	0,834	0,462	0,364	0,009	0,001
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE3	Cross-functional teams	Corr. Coefficient	-0,008	0,089	**0,279****	0,065	**0,214***	0,127	-0,011	0,044	0,184	-0,031	0,105	0,185
		Sig. (2-tailed)	0,939	0,411	0,009	0,547	0,046	0,242	0,922	0,687	0,088	0,774	0,333	0,087
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE4	Teams work at the same location	Corr. Coefficient	-0,08	0,06	0,037	0,012	-0,134	-0,074	0,011	0,015	-0,118	0,210	0,153	0,010
		Sig. (2-tailed)	0,459	0,581	0,732	0,916	0,216	0,497	0,920	0,894	0,276	0,051	0,157	0,93
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE5	Face-to-face meetings are organized as much as possible (instead of emailing/skype)	Corr. Coefficient	-0,129	0,152	0,052	0,036	-0,017	-0,189	0,015	0,104	-0,085	**0,238***	0,181	0,078
		Sig. (2-tailed)	0,232	0,161	0,634	0,740	0,874	0,079	0,888	0,339	0,436	0,026	0,093	0,474
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE6	Within the team as well as with other teams - daily stands are often organized	Corr. Coefficient	0,158	0,101	0,108	0,208	0,081	-0,086	0,068	**0,328****	-0,025	0,058	0,022	0,040
		Sig. (2-tailed)	0,145	0,352	0,319	0,053	0,459	0,426	0,529	0,002	0,821	0,592	0,838	0,711
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE7	Information and updates are always spread throughout the project team	Corr. Coefficient	0,027	0,154	0,184	0,189	**0,257***	**0,560****	0,199	**0,419****	0,105	0,135	**0,250***	0,128
		Sig. (2-tailed)	0,805	0,154	0,087	0,079	0,016	0,000	0,065	0,000	0,332	0,211	0,019	0,239
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE8	Evaluation sessions with the team are regularly organized	Corr. Coefficient	0,011	0,192	**0,260***	0,180	0,068	**0,211***	0,139	**0,256***	-0,006	0,165	**0,329****	0,180
		Sig. (2-tailed)	0,919	0,075	0,015	0,095	0,529	0,049	0,198	0,017	0,954	0,127	0,002	0,095
		N	87	87	87	87	87	87	87	87	87	87	87	87
TE9	Encourage a good collaboration with all teams	Corr. Coefficient	0,119	**0,326****	**0,393****	0,175	0,063	0,143	**0,311****	**0,232***	0,129	0,078	**0,306****	0,12
		Sig. (2-tailed)	0,274	0,002	0,000	0,106	0,562	0,188	0,003	0,031	0,234	0,474	0,004	0,268
		N	87	87	87	87	87	87	87	87	87	87	87	87
PJ1	Always be open to changes in	Corr. Coefficient	0,010	0,130	**0,235***	0,056	0,103	0,085	0,149	0,073	0,197	0,130	**0,261***	**0,230***

	the project	Sig. (2-tailed)	0,924	0,231	0,029	0,608	0,340	0,434	0,170	0,500	0,068	0,230	0,015	0,032
		N	87	87	87	87	87	87	87	87	87	87	87	87
PJ2	Throughout the project continuously focus on improving	Corr. Coefficient	**0,216***	0,067	**0,319****	0,141	0,162	**0,228***	**0,217***	**0,245***	0,175	0,154	0,189	0,183
		Sig. (2-tailed)	0,045	0,538	0,003	0,193	0,135	0,034	0,043	0,022	0,105	0,154	0,079	0,089
		N	87	87	87	87	87	87	87	87	87	87	87	87
PJ3	Divide the project up into smaller do-able projects	Corr. Coefficient	-0,008	0,047	**0,317****	-0,023	0,093	0,197	0,098	0,053	-0,005	0,070	0,090	**0,295****
		Sig. (2-tailed)	0,943	0,663	0,003	0,830	0,391	0,067	0,368	0,625	0,965	0,518	0,408	0,005
		N	87	87	87	87	87	87	87	87	87	87	87	87
PJ4	Simplify the project by completing several smaller projects	Corr. Coefficient	0,064	0,044	0,203	0,172	0,179	-0,015	0,085	0,036	0,078	-0,056	-0,123	**0,289****
		Sig. (2-tailed)	0,557	0,689	0,059	0,111	0,098	0,894	0,434	0,741	0,473	0,606	0,257	0,007
		N	87	87	87	87	87	87	87	87	87	87	87	87
KL1	The client is involved in each step to be completed in the project process	Corr. Coefficient	0,006	0,197	0,099	0,049	0,040	-0,005	0,105	-0,018	-0,014	-0,130	-0,006	0,119
		Sig. (2-tailed)	0,956	0,168	0,362	0,651	0,716	0,960	0,335	0,866	0,900	0,232	0,953	0,273
		N	87	87	87	87	87	87	87	87	87	87	87	87
KL2	The client is involved with planning sessions	Corr. Coefficient	-0,038	-0,039	-0,026	-0,023	0,028	-0,009	-0,106	0,034	-0,073	-0,100	-0,015	0,024
		Sig. (2-tailed)	0,726	0,719	0,811	0,835	0,798	0,937	0,330	0,753	0,504	0,357	0,894	0,827
		N	87	87	87	87	87	87	87	87	87	87	87	87
KL3	The client is involved with evaluation sessions	Corr. Coefficient	0,048	0,083	0,104	0,010	-0,027	0,139	-0,036	-0,092	0,071	0,096	0,119	**0,268***
		Sig. (2-tailed)	0,657	0,445	0,336	0,926	0,806	0,199	0,741	0,396	0,513	0,377	0,274	0,012
		N	87	87	87	87	87	87	87	87	87	87	87	87
KL4	The client also works at the same location at the project teams	Corr. Coefficient	0,066	0,063	0,057	0,046	0,156	-0,015	-0,054	0,039	-0,189	-0,133	0,165	0,056
		Sig. (2-tailed)	0,545	0,564	0,597	0,671	0,149	0,888	0,619	0,720	0,080	0,219	0,127	0,606
		N	87	87	87	87	87	87	87	87	87	87	87	87
KL5	The collaboration with the client is highly important	Corr. Coefficient	0,082	0,178	**0,356****	0,101	-0,143	**0,287****	0,131	**0,225***	0,041	0,092	**0,235***	0,031
		Sig. (2-tailed)	0,449	0,098	0,001	0,352	0,186	0,007	0,225	0,036	0,706	0,397	0,029	0,775
		N	87	87	87	87	87	87	87	87	87	87	87	87
ME1	The project evolves around motivated people	Corr. Coefficient	0,116	0,117	**0,357****	0,095	0,164	**0,271***	0,129	**0,249***	-0,053	0,210	**0,258***	**0,214***
		Sig. (2-tailed)	0,285	0,280	0,001	0,379	0,128	0,011	0,232	0,020	0,623	0,051	0,016	0,046
		N	87	87	87	87	87	87	87	87	87	87	87	87
ME2	Employees trust each other	Corr. Coefficient	0,124	0,057	**0,319****	-0,029	0,150	**0,248***	0,062	0,158	0,089	0,166	**0,328****	**0,256***
		Sig. (2-tailed)	0,254	0,602	0,003	0,789	0,166	0,021	0,571	0,143	0,414	0,126	0,002	0,017
		N	87	87	87	87	87	87	87	87	87	87	87	87
ME3	Employees help each other	Corr. Coefficient	0,124	0,198	**0,491****	0,064	0,086	**0,325****	0,014	**0,233***	-0,029	0,094	**0,377****	**0,305****
		Sig. (2-tailed)	0,254	0,065	0,000	0,556	0,428	0,002	0,899	0,030	0,792	0,389	0,000	0,004
		N	87	87	87	87	87	87	87	87	87	87	87	87
DO1	Avoid long and detailed reports	Corr. Coefficient	0,162	**0,433****	0,165	-0,001	**0,35***	0,187	**0,216***	**0,285****	-0,016	0,161	**0,364****	0,147
		Sig. (2-tailed)	0,133	0,000	0,126	0,991	0,029	0,083	0,044	0,008	0,880	0,136	0,001	0,174
		N	87	87	87	87	87	87	87	87	87	87	87	87
DO2	Only plan for the short-term of the project	Corr. Coefficient	-0,520	0,077	-0,066	-0,037	0,182	0,044	-0,033	0,079	-0,165	0,034	0,168	0,006
		Sig. (2-tailed)	0,631	0,476	0,544	0,733	0,092	0,683	0,763	0,466	0,126	0,758	0,119	0,995
		N	87	87	87	87	87	87	87	87	87	87	87	87
DO3	Minimalize documentation	Corr. Coefficient	-0,030	**0,297****	0,177	0,169	0,182	0,155	0,100	**0,397****	-0,083	0,162	**0,300****	0,080
		Sig. (2-tailed)	0,978	0,005	0,101	0,117	0,091	0,152	0,359	0,000	0,447	0,133	0,005	0,463
		N	87	87	87	87	87	87	87	87	87	87	87	87
LO1	All involved parties work at the same location	Corr. Coefficient	-0,078	-0,084	0,042	0,034	-0,210	-0,087	-0,035	-0,064	0,193	-0,063	0,107	0,145
		Sig. (2-tailed)	0,470	0,439	0,701	0,753	0,051	0,425	0,747	0,554	0,074	0,564	0,325	0,180

	throughout the project	N	87	87	87	87	87	87	87	87	87	87	87	87
LO2	Open workplaces encourage collaboration	Corr. Coefficient	0,032	0,173	**0,292****	0,011	0,055	0,113	-0,004	0,093	-0,097	0,026	0,178	0,188
		Sig. (2-tailed)	0,771	0,109	0,006	0,919	0,612	0,299	0,973	0,391	0,372	0,811	0,099	0,082
		N	87	87	87	87	87	87	87	87	87	87	87	87
LO3	Project rooms for the entire length of the project (e.g. to hang the planning there)	Corr. Coefficient	-0,006	0,024	0,198	0,053	-0,058	0,141	-0,147	0,083	0,151	0,059	0,135	0,079
		Sig. (2-tailed)	0,953	0,829	0,066	0,623	0,595	0,193	0,193	0,447	0,164	0,590	0,211	0,469
		N	87	87	87	87	87	87	87	87	87	87	87	87
LO4	Use color-coding for documents hanging in project rooms	Corr. Coefficient	0,026	0,066	-0,049	0,084	-0,018	0,003	0,089	0,076	0,161	0,064	-0,007	0,069
		Sig. (2-tailed)	0,809	0,542	0,655	0,441	0,871	0,980	0,413	0,483	0,136	0,557	0,946	0,524
		N	87	87	87	87	87	87	87	87	87	87	87	87

Appendix D2: Correlation Analysis Clusters

Correlation analysis all agile clusters & project value cluster

#	Ranking All Agile Clusters & Project Value Cluster	Corr. Coefficient	Strength	Significance
1	Deliveries & Project Value	0,327	Moderate	0,002
2	Documentation & Project Value	0,255	Weak	0,017
3	Teams & Project Value	0,227	Weak	0,034
4	Clients & Project Value	0,160	Weak	0,140
5	Attitudes & Project Value	0,159	Weak	0,142
6	Project & Project Value	0,133	Weak	0,221
7	Process & Project Value	0,108	Weak	0,319
8	Planning & Project Value	0,101	Weak	0,353
9	Location & Project Value	0,007	Very Weak	0,949

Correlation analysis all agile clusters & process value cluster

#	Ranking All Agile Clusters & Process Value Cluster	Corr. Coefficient	Strength	Significance
1	Teams & Process Value	0,441	Moderate	0,000
2	Attitudes & Process Value	0,400	Moderate	0,000
3	Documentation & Process Value	0,370	Moderate	0,000
4	Process & Process Value	0,363	Moderate	0,001
5	Project & Process Value	0,335	Moderate	0,002
6	Deliveries & Process Value	0,256	Weak	0,017
7	Clients & Process Value	0,198	Weak	0,065
8	Planning & Process Value	0,175	Weak	0,105
9	Location & Process Value	0,138	Weak	0,204

1. Correlation analysis deliveries cluster and all value measures

#	Ranking Deliveries Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Early and frequent delivery and value of project scope	0,341	Moderate	0,001
2	Early and frequent delivery and value of project quality	0,275	Weak	0,010
3	Early and frequent delivery and value of project time	0,274	Weak	0,010
4	Tracking project deliveries continuously and value of process attitudes	0,268	Weak	0,012
5	Tracking project deliveries continuously and value of process budgeting	0,255	Weak	0,017
6	Early and frequent delivery and value of process scheduling	0,242	Weak	0,024

2. Correlation analysis process cluster and all value measures

#	Ranking Process Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Evolutionary development that aims to continuously improve and value of project scope	0,465	Moderate	0,000
2	Evolutionary development that aims to continuously improve and value of teamwork	0,311	Moderate	0,003
3	Modify aims and planning accordingly and value of communication	0,306	Moderate	0,004
4	Evolutionary development that aims to continuously improve and value of change management	0,273	Weak	0,010
5	Evolutionary development that aims to continuously improve and value of scheduling	0,264	Weak	0,013
6	Focus on frequent delivery through and iterative process and value of performance information	0,247	Weak	0,021

7	Focus on frequent delivery through and iterative process and value of communication	0,241	Weak	0,025
8	Evolutionary development that aims to continuously improve and value of interim client and stakeholder satisfaction	0,230	Weak	0,032
9	Evolutionary development that aims to continuously improve and value of project costs	0,228	Weak	0,034
10	Evolutionary development that aims to continuously improve and value of individual attitudes	0,227	Weak	0,034
11	Modify aims and planning accordingly and value of budgeting	0,226	Weak	0,035

3. Correlation analysis planning cluster and all value measures

#	Ranking Planning Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Regularly revise original planning and re-prioritize and value of performance information	0,285	Moderate	0,007
2	Regularly revise original planning and re-prioritize and value of communication	0,270	Moderate	0,012
3	Integral planning sessions and value of communication	0,246	Moderate	0,022
4	Integral planning sessions and value of project costs	0,238	Moderate	0,026

4. Correlation analysis teams and value measures

#	Ranking Teams Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Information and updates are always spread and value of resources	0,560	Strong	0,000
2	Information and updates are always spread and value of communication	0,419	Moderate	0,000
3	Encourage a good collaboration with all teams and value of teamwork	0,393	Moderate	0,000
4	Self-management attitude and value of change management	0,340	Moderate	0,001
5	Evaluation sessions with the team are regularly organized and value of individual attitudes	0,329	Moderate	0,002
6	Within the team as well as with other teams - daily stands are often organized and value of communication	0,328	Moderate	0,002
7	Encourage a good collaboration with all teams and value of interim client and stakeholder satisfaction	0,326	Moderate	0,002
8	Encourage a good collaboration with all teams and value of process scope	0,311	Moderate	0,003
9	Encourage a good collaboration with all teams and value of individual attitudes	0,306	Moderate	0,004
10	Cross-functional teams and value of teamwork	0,279	Weak	0,009
11	Self-management attitude and value of individual attitudes	0,278	Weak	0,009
12	Self-management attitude and value of teamwork	0,266	Weak	0,013
13	Self-management attitude and value of project scope	0,263	Weak	0,014
14	Evaluation sessions with the team are regularly organized and value of teamwork	0,260	Weak	0,015
15	Information and updates are always spread and value of performance information	0,257	Weak	0,016
16	Evaluation sessions with the team are regularly organized and value of communication	0,256	Weak	0,017
17	Encourage a good collaboration and value of project scope	0,250	Weak	0,020
18	Information and updates are always spread and value of individual attitudes	0,250	Weak	0,019
19	Face-to-face meetings are organized as much as possible and value of project scope	0,242	Weak	0,024
20	Face-to-face meetings are organized as much as possible and value of process quality	0,238	Weak	0,026
21	Encourage a good collaboration with all teams and value of communication	0,232	Weak	0,031
22	Encourage a good collaboration and value of project clients satisfaction	0,227	Weak	0,034
23	Self-management attitude and value of project clients satisfaction	0,221	Weak	0,040
24	Cross-functional teams and value of performance information	0,214	Weak	0,046
25	Evaluation sessions with the team are regularly organized and value of resources	0,211	Weak	0,049
26	The project is organized in many smaller teams and value of resources	-0,214	Weak	0,046

5. Correlation analysis project cluster and all value measures

#	Ranking Project Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Throughout the project continuously focus on improving and value of teamwork	0,319	Moderate	0,003
2	Divide the project up into smaller do-able project and value of teamwork	0,317	Moderate	0,003
3	Divide the project up into smaller do-able project and value of change management	0,295	Moderate	0,005
4	Simplifying the project by completing smaller project and value of change management	0,289	Weak	0,007
5	Always being open to changes in the project and value of individual attitudes	0,261	Weak	0,015
6	Throughout the project continuously focus on improving and value of communication	0,245	Weak	0,022
7	Always being open to changes in the project and value of teamwork	0,235	Weak	0,029
8	Always being open to changes in the project and value of change management	0,230	Weak	0,032
9	Throughout the project continuously focus on improving and value of resources	0,228	Weak	0,034
10	Throughout the project continuously focus on improving and value of project scope	0,226	Weak	0,035
11	Simplifying the project by completing smaller project and value of project costs	0,222	Weak	0,039
12	Throughout the project continuously focus on improving and value of process scope	0,217	Weak	0,043
13	Throughout the project continuously focus on improving and value of scheduling	0,216	Weak	0,045

6. Correlation analysis clients cluster and all value measures

#	Ranking Clients Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	The collaboration with the client is highly important and value of teamwork	0,356	Moderate	0,001
2	The collaboration with the client is highly important and value of resources	0,287	Weak	0,007
3	The client is involved with evaluation sessions and value of change management	0,268	Weak	0,012
4	The collaboration with the client is highly important and value of individual attitudes	0,235	Weak	0,029
5	The collaboration with the client is highly important and value of communication	0,225	Weak	0,036

7. Correlation analysis attitude cluster and all value measures

#	Ranking Attitudes Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Employees help each other and value of teamwork	0,491	Moderate	0,000
2	Employees help each other and value of individual attitudes	0,377	Moderate	0,000
3	The project evolves around motivated people and value of teamwork	0,357	Moderate	0,001
4	Employees trust each other and value of individual attitudes	0,328	Moderate	0,002
5	Employees help each other and value of resources	0,325	Moderate	0,002
6	Employees trust each other and value of teamwork	0,319	Moderate	0,003
7	Employees help each other and value of change management	0,305	Moderate	0,004
8	The project evolves around motivated people and value of resources	0,271	Weak	0,011
9	The project evolves around motivated people and value of individual attitudes	0,258	Weak	0,016
10	Employees trust each other and value of change management	0,256	Weak	0,017
11	The project evolves around motivated people and value of communication	0,249	Weak	0,02
12	Employees trust each other and value of resources	0,248	Weak	0,021
13	The project evolves around motivated people and value of project quality	0,234	Weak	0,029
14	Employees help each other and value of communication	0,233	Weak	0,030
15	The project evolves around motivated people and value of change management	0,214	Weak	0,046

16	The project evolves around motivated people and value of project scope	0,213	Weak	0,048

8. Correlation analysis documentation cluster and all value measures

#	Ranking Documentation Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Avoid long and detailed reports and value of project clients satisfaction	0,478	Moderate	0,000
2	Avoid long and detailed reports and value of interim clients and stakeholder satisfaction	0,433	Moderate	0,000
3	Minimize documentation and value of interim clients and stakeholder satisfaction	0,374	Moderate	0,000
4	Avoid long and detailed reports and value of individual attitudes	0,364	Moderate	0,001
5	Avoid long and detailed reports and value of performance information	0,350	Moderate	0,029
6	Avoid long and detailed reports and value of communication	0,285	Weak	0,008
7	Avoid long and detailed reports and value of project quality	0,231	Weak	0,031
8	Avoid long and detailed reports and value of process scope	0,216	Weak	0,044
9	Only plan for the short-term and value of project costs	-0,240	Weak	0,250

9. Correlation analysis location cluster and all value measures

#	Ranking Location Cluster & All Value Measures	Corr. Coefficient	Strength	Significance
1	Open workplaces encourage collaboration and value of teamwork	0,292	Weak	0,006

10. Correlation analysis project value cluster and all agile elements

#	Ranking Project Value & All Agile Elements	Corr. Coefficient	Strength	Significance
1	Avoid long and detailed reports and value of project clients satisfaction	0,478	Moderate	0,000
2	Evolutionary development that aims to continuously improve and value of project scope	0,465	Moderate	0,000
3	Early and frequent delivery and value of project scope	0,341	Moderate	0,001
4	Early and frequent delivery and value of project quality	0,275	Weak	0,010
5	Early and frequent delivery and value of project time	0,274	Weak	0,010
6	Self-management attitude and value of project scope	0,263	Weak	0,014
7	Encourage a good collaboration and value of project scope	0,250	Weak	0,020
8	Face-to-face meetings are organized as much as possible and value of project scope	0,242	Weak	0,024
9	Integral planning sessions and value of project costs	0,238	Weak	0,026
10	The project evolves around motivated people and value of project quality	0,234	Weak	0,029
11	Avoid long and detailed reports and value of project quality	0,231	Weak	0,031
12	Evolutionary development that aims to continuously improve and value of project costs	0,228	Weak	0,034
13	Encourage a good collaboration and value of project clients satisfaction	0,227	Weak	0,034
14	Throughout the project continuously focus on improving and value of project scope	0,226	Weak	0,035
15	Simplifying the project by completing smaller project and value of project costs	0,222	Weak	0,039
16	Self-management attitude and value of project clients satisfaction	0,221	Weak	0,040
17	The project evolves around motivated people and value of project scope	0,213	Weak	0,048

11. Correlation analysis process value and all agile elements

#	Ranking Process Value & All Agile Elements	Corr. Coefficient	Strength	Significance
1	Information and updates are always spread and value of resources	0,560	Strong	0,000
2	Employees help each other and value of teamwork	0,491	Moderate	0,000
3	Avoid long and detailed reports and value of interim clients and stakeholder satisfaction	0,433	Moderate	0,000

4	Information and updates are always spread and value of communication	0,419	Moderate	0,000
5	Encourage a good collaboration with all teams and value of teamwork	0,393	Moderate	0,000
6	Employees help each other and value of individual attitudes	0,377	Moderate	0,000
7	Minimize documentation and value of clients satisfaction	0,374	Moderate	0,000
8	Avoid long and detailed reports and value of individual attitudes	0,364	Moderate	0,001
9	The project evolves around motivated people and value of teamwork	0,357	Moderate	0,001
10	The collaboration with the client is highly important and value of teamwork	0,356	Moderate	0,001
11	Avoid long and detailed reports and value of performance information	0,350	Moderate	0,029
12	Self-management attitude and value of change management	0,340	Moderate	0,001
13	Evaluation sessions with the team are regularly organized and value of individual attitudes	0,329	Moderate	0,002
14	Within the team as well as with other teams - daily stands are often organized and value of communication	0,328	Moderate	0,002
15	Employees trust each other and value of individual attitudes	0,328	Moderate	0,002
16	Encourage a good collaboration with all teams and value of interim client and stakeholder satisfaction	0,326	Moderate	0,002
17	Employees help each other and value of resources	0,325	Moderate	0,002
18	Throughout the project continuously focus on improving and value of teamwork	0,319	Moderate	0,003
19	Employees trust each other and value of teamwork	0,319	Moderate	0,003
20	Divide the project up into smaller do-able project and value of teamwork	0,317	Moderate	0,003
21	Evolutionary development that aims to continuously improve and value of teamwork	0,311	Moderate	0,003
22	Encourage a good collaboration with all teams and value of process scope	0,311	Moderate	0,003
23	Modify aims and planning accordingly and value of communication	0,306	Moderate	0,004
24	Encourage a good collaboration with all teams and value of individual attitudes	0,306	Moderate	0,004
25	Employees help each other and value of change management	0,305	Moderate	0,004
26	Divide the project up into smaller do-able project and value of change management	0,295	Moderate	0,005
27	Open workplaces encourage collaboration and value of teamwork	0,292	Weak	0,006
28	Simplifying the project by completing smaller project and value of change management	0,289	Weak	0,007
29	The collaboration with the client is highly important and value of resources	0,287	Weak	0,007
30	Regularly revise original planning and re-prioritize and value of performance information	0,285	Weak	0,007
31	Avoid long and detailed reports and value of communication	0,285	Weak	0,008
32	Cross-functional teams and value of teamwork	0,279	Weak	0,009
33	Self-management attitude and value of individual attitudes	0,278	Weak	0,009
34	Evolutionary development that aims to continuously improve and value of change management	0,273	Weak	0,010
35	The project evolves around motivated people and value of resources	0,271	Weak	0,011
36	Regularly revise original planning and re-prioritize and value of communication	0,270	Weak	0,012
37	Tracking project deliveries continuously and value of process attitudes	0,268	Weak	0,012
38	The client is involved with evaluation sessions and value of change management	0,268	Weak	0,012
39	Self-management attitude and value of teamwork	0,266	Weak	0,013
40	Evolutionary development that aims to continuously improve and value of scheduling	0,264	Weak	0,013
41	Always being open to changes in the project and value of individual attitudes	0,261	Weak	0,015
42	Evaluation sessions with the team are regularly organized and value of teamwork	0,260	Weak	0,015
43	The project evolves around motivated people and value of individual attitudes	0,258	Weak	0,016
44	Information and updates are always spread and value of performance information	0,257	Weak	0,016
45	Evaluation sessions with the team are regularly organized and value of communication	0,256	Weak	0,017

46	Employees trust each other and value of change management	0,256	Weak	0,017
47	Tracking project deliveries continuously and value of process budgeting	0,255	Weak	0,017
48	Information and updates are always spread and value of individual attitudes	0,250	Weak	0,019
49	The project evolves around motivated people and value of communication	0,249	Weak	0,02
50	Employees trust each other and value of resources	0,248	Weak	0,021
51	Focus on frequent delivery through and iterative process and value of performance information	0,247	Weak	0,021
52	Integral planning sessions and value of communication	0,246	Weak	0,022
53	Throughout the project continuously focus on improving and value of communication	0,245	Weak	0,022
54	Early and frequent delivery and value of process scheduling	0,242	Weak	0,024
55	Focus on frequent delivery through and iterative process and value of communication	0,241	Weak	0,025
56	Face-to-face meetings are organized as much as possible and value of process quality	0,238	Weak	0,026
57	Always being open to changes in the project and value of teamwork	0,235	Weak	0,029
58	The collaboration with the client is highly important and value of individual attitudes	0,235	Weak	0,029
59	Employees help each other and value of communication	0,233	Weak	0,030
60	Encourage a good collaboration with all teams and value of communication	0,232	Weak	0,031
61	Evolutionary development that aims to continuously improve and value of interim client and stakeholder satisfaction	0,230	Weak	0,032
62	Always being open to changes in the project and value of change management	0,230	Weak	0,032
63	Throughout the project continuously focus on improving and value of resources	0,228	Weak	0,034
64	Evolutionary development that aims to continuously improve and value of individual attitudes	0,227	Weak	0,034
65	Modify aims and planning accordingly and value of budgeting	0,226	Weak	0,035
66	The collaboration with the client is highly important and value of communication	0,225	Weak	0,036
67	Throughout the project continuously focus on improving and value of process scope	0,217	Weak	0,043
68	Throughout the project continuously focus on improving and value of scheduling	0,216	Weak	0,045
69	Avoid long and detailed reports and value of process scope	0,216	Weak	0,044
70	Cross-functional teams and value of performance information	0,214	Weak	0,046
71	The project evolves around motivated people and value of change management	0,214	Weak	0,046
72	Evaluation sessions with the team are regularly organized and value of resources	0,211	Weak	0,049
73	The project is organized in many smaller teams and value of resources	-0,214	Weak	0,046

Appendix E1: Expert Validation

Alvast bedankt voor het deelnemen aan de expert validatie sessie voor mijn afstuderen. Aangezien het grootste deel van de sessie bestaat uit een groepsdiscussie zou ik u willen vragen om deze enquête eerst individueel in te vullen voor dat de discussie kan starten.

DEEL 1: ALGEMENE VRAGEN

Naam expert:										
Afdeling:										
Project rol:	Project leider/manager			Project directeur			Deel project leider			
Jaren werkervaring:										
Hoogst behaalde onderwijs diploma:										
Project management cursus voltooid?	Ja					Nee				
Value engineering cursus voltooid?	Ja					Nee				
Bekendheid met agile project management:	1	2	3	4	5	6	7	8	9	10

DEEL 2: DISCUSSIE OVER HET MODEL (Open vragen)

Denkt u dat dit model toepasbaar is voor infrastructuur projecten? A.u.b. antwoord toelichten.
Welke onderdelen van het model zijn momenteel onduidelijk? A.u.b. antwoord toelichten.
Wat moet er veranderen om het model toepasbaar te maken voor infrastructuur projecten? A.u.b. antwoord toelichten.
Bent u het eens met de toegevoegde waarde door agile project management? Waarom? A.u.b. antwoord toelichten.
Denkt u dat de huidige cultuur bij W+B geschikt is om dit model toe te passen bij projecten? A.u.b. antwoord toelichten.
Wat zijn voor u de voorwaarden om dit model toe te kunnen passen in de praktijk? A.u.b. antwoord toelichten.

Mocht u nog verdere opmerkingen hebben over de stappen in het model, kunt u ze dan toelichten in het tabel hier onder?

Stap	Opmerking(en)
1	
2	
3	
4	

DEEL 3: TOEGEVOEGDE WAARDE VALUE AGILE PROJECT MANAGEMENT (Ja/Nee vragen)

#	Agile Element	Bent u het hier mee eens (Ja/Nee)	
1.	Pas de doelstellingen en planning regelmatig aan zodat ze actueel blijven.	Ja	Nee
2.	Regelmatig de planning en activiteiten herzien.	Ja	Nee
3.	Focus op continue verbeteren gedurende het project.	Ja	Nee
4.	Breek het project op in meerdere kleinere uitvoerbare projecten.	Ja	Nee
5.	Versimpel het project in meerdere kleine projecten.	Ja	Nee
6.	Het project evolueert rond gemotiveerde mensen.	Ja	Nee
7.	Werknemers vertrouwen elkaar.	Ja	Nee
8.	Werknemers helpen elkaar.	Ja	Nee
9.	Open werkplekken stimuleren samenwerking.	Ja	Nee
10.	Evolutionaire manier van ontwikkelen voortdurend gericht op verbeteren.	Ja	Nee
11.	Self-management van teams (weg van lange hiërarchie).	Ja	Nee
12.	Cross-functionele teams (functie overschrijdende rollen per team).	Ja	Nee
13.	Organiseer zowel binnen als buiten het team dagelijkse stand-up overleggen.	Ja	Nee
14.	Informatie en updates worden altijd aan iedereen verspreid.	Ja	Nee
15.	Vaak evaluatie sessies organiseren.	Ja	Nee
16.	Moedig een goede samenwerking aan	Ja	Nee
17.	De samenwerking met de klant is ontzettend belangrijk	Ja	Nee
18.	Vermijd lange en gedetailleerde rapporten (maak ze beknopt).	Ja	Nee
19.	Minimaliseer documentatie wanneer mogelijk	Ja	Nee

DEEL 4: AANDACHTSPUNTEN BIJ TOEPASSING (POTENTIEEL VERLOREN WAARDE)

#	Agile Element	Bent u het hier mee eens (Ja/Nee)	
1.	Evaluaties na iedere levering (-> niet altijd vanwege overkill en ook aangezien niet ieder product even cruciaal is voor het project).	Ja	Nee
2.	Veranderingen in een project kunnen altijd (-> niet altijd want een specialist moet ook zijn werk kunnen doen en veranderingen moet gereguleerd worden).	Ja	Nee
3.	Dagelijkse stand-up overleggen (-> dagelijks is niet altijd van toepassing).	Ja	Nee
4.	Teams werken altijd op dezelfde locatie met elkaar (-> iedere dag zal niet mogelijk zijn maar 1 keer per week wel).	Ja	Nee
5.	De klant is betrokken bij iedere stap in het project (-> de klant kan niet altijd aanwezig zijn en dat al ook niet altijd nodig zijn).	Ja	Nee
6.	De klant is betrokken bij planningssessies (-> te vaak de klant betrekken zal ook niet nodig zijn. Op afgesproken moment is voldoende).	Ja	Nee
7.	De klant werkt altijd op dezelfde locatie als het project team (-> dit is niet altijd nodig en kan ook storend zijn).	Ja	Nee
8.	Alle betrokkenen in het project moeten altijd samen op dezelfde locatie werken (-> dit is vaak niet mogelijk omdat niet iedereen op dezelfde dagen aan het project werkt).	Ja	Nee
9.	Project kamers waar permanent project documentatie hangt (-> deze ruimtes zijn er vaak niet, en als ze er zijn, zijn ze te klein).	Ja	Nee
10.	Kleurcodering van documenten (-> te veel extra moeite en ook weer verwarring)	Ja	Nee

#	Ranking Results Survey Correlation	Ranking Results Expert Validation
1	High	High
2	High	Medium
3	High	Medium
4	High	Medium
5	High	High
6	High	High
7	High	Medium
8	High	High
9	High	High
10	Medium	High
11	Medium	High
12	Medium	High
13	Medium	Low
14	Medium	Medium
15	Medium	Low
16	Medium	High
17	Medium	High
18	Medium	Medium
19	Medium	Medium

Validation Ranking of Added Value

#	Ranking Results Expert Validation
1	High
2	High
3	High
4	Medium
5	Medium
6	Medium
7	Medium
8	Medium
9	Low
10	None

Validation Ranking of Areas of Attention