STAKEHOLDER RELATIONSHIP MANAGEMENT
ON COMPLEXITY AND INTEGRATED CONTRACTS
IN LARGE INFRASTRUCTURE PROJECTS

STAKEHOLDERS

CONTRACTOR

CLIENT

MASTER THESIS - TOM HEERINGA
CONSTRUCTION MANAGEMENT & ENGINEERING
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ON COMPLEXITY AND INTEGRATED CONTRACTS IN LARGE INFRASTRUCTURE PROJECTS

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Construction Management & Engineering

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This master thesis is my graduation research, which is the last part of the master program Construction Management and Engineering at the Delft University of Technology.

My interest in the behavior of people, together with the fascination for complex, technical environments constituted the motivation to let the topic of this master thesis arise. People’s behavior and the accompanying decision making process is a complex phenomenon by itself, not to mention when it takes place in a technical environment with high complexity. During my life I worked together with many different types of persons, for school projects, but also during different side jobs. The master program provided me with knowledge about the construction industry in many ways. Subjects about financing, ethics, building legislation, project dynamics, asset management, project management together with site visits and collaborative projects created a broad foundation about the construction industry. During the side job as building and terrain manager in the harbor of Terneuzen I had to deal with different people, who all wanted to express their varying demands and wishes in the construction projects.

These interests got a more concrete shape towards the topic of this research during a foreign study project. Together with a fellow student from the master Construction Management and Engineering, we started a real research on the behavior and decision making of people in a complex technical environment. We went to Galveston (Texas) for the development of an integrated design for the Bolivar Peninsula as a part of the ‘Ike Dike’ risk reduction strategy. The University of Texas A&M designed a structure along the coast to protect the Houston-Galveston Area against floods resulting from hurricanes like ‘Ike’. The Bolivar Peninsula was one of the six parts of this structure for which we had to make a design, along with four other students from Hydraulic Engineering and Transport Infrastructure and Logistics. Engineering the flood barrier was the responsibility of HE, while we as CME students were responsible for the feasibility in terms of stakeholder management, financing and construction of the structure. I learned that constructing an infrastructure project in Texas was really different from constructing it in the Netherlands, because there is no governmental authority which is responsible and stakeholder support for flood defenses is minimal. Through stakeholder analyses, cost benefit analyses, and stakeholder strategies we created a general strategy to design the flood structure.

With this knowledge and experiences about stakeholder management and complex infrastructure projects, I searched for a graduation project which had the opportunity to combine these subjects. In the Dutch construction industry, especially in Large Infrastructure Projects (LIPs), elements related to these subjects come back in one discipline: Stakeholder Relationship Management (SRM) which means omgevingsmanagement in Dutch. Stakeholder management, decision making, complexity and responsibility division are all elements within the topic, which have influence on LIPs. The discipline officially exists only since several decades, but already has a major impact on Dutch LIPs. VolkerInfra gave me the opportunity to perform this master thesis about that topic under their authority, during the finishing months of my master program. VolkerInfra is part of the VolkerWessels organization, which is one of the largest contractors in the Netherlands. The outcome of this research should provide added value for the execution of SRM in this organization.

I would like to thank my supervisors at the Delft University of Technology for guiding me with much expertise and important feedback. Furthermore, I would like to thank my external supervisors from VolkerInfra for proving me a workspace, good feedback and guidance with the case study projects. I also want to thank all interviewees from different organizations who have cooperated as client or contractor in a case project, for providing me valuable and practical information. Finally I want to thank all surrounding people that helped to create this report by giving feedback, advice and information, or just talked to me about the topic and issues.

I hope that you will read this master thesis with pleasure and interest

Tom Heeringa
Delft, December 2015
INTRODUCTION

Implementing a Large Infrastructure Project (LIP) in physical environments inevitably has a large impact on its surroundings and vice versa. The characteristics of LIPs (scope changes, long planning horizons, multi-actor processes, complex interfaces and unusual or new technologies) are causing conflicting interests between stakeholders and bring complexities during the execution. Rapid developments in the current society cause that interaction with surrounding stakeholders has become inevitable (KING, 2010). The Dutch ‘MaVa’ project is a current LIP in the Netherlands in which several issues occurred, leading to cost- and time overruns (Koenen, 2014). This LIP is elaborated upon in the introduction (1) as an example of the core problem. The interaction with involved stakeholders leads to conflicts, causing issues in LIPs. These issues must be solved with the relatively new discipline: Stakeholder Relationship Management (SRM), which has developed from unfamiliar to indispensable during LIPs over the last several decades (Clafis, 2015). The mentioned issues always occurred during construction activities, but since SRM is a discipline problems are documented to learn from and to search for solutions (Verweij, 2015).

There are two key components in the field of LIPs which are assumed to cause major issues in the current execution of SRM: increasing complexity and the introduction of integrated contracts. Complexity has always been present in the working field of LIPs, but due to the rapid developments in society complexity is increasing very fast. The difficulty with complexity is that it is unpredictable and occurs unforeseen (Verweij, 2015). LIPs are getting increasingly complex in practical and scientific ways (Hertogh & Westerveld, 2009). Moreover, the introduction of integrated contracts causes changes in the risk- and responsibility division between client and contractor (Nijpels, 2011). Tensions instead of the intended added values and strict boundaries between public and private responsibilities emanated from the implementation of these contracts (Verhees, van Marrewijk, Leendertse, & Arts, 2015). For example: freedom and innovation in the design phase are suppressed via strict legislation and more responsibilities are shifted to the private market, while the contractor is not always the most competent organization to tackle the issues.

The goal of this research is to discover current issues with complexity and integrated contracts which influence SRM and create a solution tool to improve the execution of SRM in LIPs. The main research question in order to achieve this objective is stated as follows:

What contributes in solving issues with complexity and integrated contracts in Stakeholder Relationship Management during Large Infrastructure Projects?

This research is executed under the supervision of VolkerInfra, which is part of the VolkerWessels organization. That organization is one of the largest contractors in the Netherlands. The outcome of this research should provide added value for the execution of SRM in this organization. Therefore it must be stated that the outcome is created with influences from a contractor. Although the solution should contribute to the execution of SRM in practice for this contractor, the solution is developed with an objective viewpoint. This allows other contractors to use it, as well as making it applicable for clients like ProRail and Rijkswaterstaat (RWS).

LITERATURE

A literature study (3) will be conducted to theoretically investigate SRM, complexity and integrated contracts in LIPs. Definitions and structures from different resources about the three research components will be elaborated upon. To conclude the literature study a theoretical framework will be created in the form of a model of the current SRM approach with a set of variables from complexity and integrated contracts. This is done in order to answer the following sub-question:

How can SRM, complexity and integrated contracts in LIPs be defined and what do they entail?
SRM has become one of the main disciplines in executing a LIP, because it is inevitable that a LIP has an impact on its environment (Proflexis, 2015). A general definition of SRM will be made out of several literature, which will be used for the rest of this report. The practical structure to execute SRM is divided in five working fields: stakeholder management, communication, participation, conditioning and traffic management. The scientific structure is described with process management, because stakeholder management has been researched in this academic field. Different methods are currently being developed for the execution of SRM. The leading approaches all hold a step-based plan for the execution of SRM and will be elaborated upon in this research.

The current social developments have made LIPs more complex, while they are executed in increasingly complex environments. Complexity is researched throughout history in scientific- and practical ways, by different schools of thought. Out of these developments six complexity types arose: social-, technical-, organizational-, legal-, financial- and temporal complexity. Detail- and dynamic complexity can be seen as the scientific structure which occur across the six practical complexity types (Hertogh & Westerveld, 2009). Dynamic complexity is seen as the most important complexity in the scientific structure and social complexity is seen as most important in the practical structure. The introduction of integrated contracts in Dutch LIPs causes ongoing changes in the responsibility and risk division between the public client and the private contractor. Many tasks and responsibilities are shifted to contractors who must execute new tasks including SRM (Visser, 2013). The current situation reveals that underlying tensions instead of the intended added values arise with the introduction of integrated contracts. The more integrated a contract is, the more responsibilities are shifted to contractors and responsibilities are separated. This leads to discussions between client and contractor about the actual responsibility division.

A theoretical framework contains the findings from the three research components at the end of the literature study. The framework consists of three parts: a step-based model from the literature about SRM and two sets of variables from the literature about complexity and integrated contracts as input for this model. The framework forms the basis for the case study interviews (4) and the theoretical input for the solution tool (5).

CASE STUDY RESEARCH

A case study research (4) will be conducted to give insight in the current developments of SRM, complexity and integrated contracts in practice, during LIPs. Six Dutch LIPs are researched on issues and findings in relation to the three research components. The findings are a result of six case descriptions and twelve interviews with respondents from both client and contractor. A cross-case analysis compares the different case studies with each other to create general findings. The findings are reviewed by the theoretical framework and afterwards used as design criteria for the solution tool (5). This will lead to an answer to the following sub-question:

How are SRM, complexity and integrated contracts approached in practice?

The interview questions have been created with the theoretical framework and the outcome was a set of comparisons to compare the cases in the cross-case analysis. ‘A standard methods to execute SRM’ is an example of a comparison for the SRM component and has been acknowledged to be beneficial in LIPs. Also ‘collaboration with the client’ was a comparison and was crucial in the cases, because in the three cases where collaboration with the client was high, it was recognized as the key factor for success. ‘Participation with stakeholders’ was also important in the case studies. In four out of six cases the SRM managers had to participate with stakeholders in order to execute the LIP. Main difficulties were contractual changes and misinterpretation of agreements between client, contractor and stakeholders.

In the same way several comparisons about the complexity component were developed to compare the cases. All issues that occurred contained one or more of the six practical complexity types, although not every complexity was equally important. In two cases social complexity was the most important, in two other cases technical complexity important and in the last two cases organizational complexity was the hardest to manage. Legal-, financial- and time complexity were also important, but to a lesser extent than the other complexities. Next to the six complexities of the practical structure, dynamic complexity was recognized in the cases. In most case studies changes occurred during the execution of a LIP, which caused issues.
In all cases shifting responsibilities to the private market due to the introduction of integrated contracts was recognized by the respondents. Responsibilities were strictly divided in all cases, but in three out of six projects the SRM managers executed SRM tasks outside the contract and shared responsibilities. This resulted in solutions, which were beneficial for the LIP. In all cases the intended added values of integrated contracts (like design freedom) were recognized at the beginning of the project, but the underlying tensions came to the light mainly because the static character and strict boundaries of the contract. The main disadvantage as stated by all respondents in the case studies is the lack of flexibility in integrated contracts.

**SOLUTION TOOL**

A potential solution tool (5) has been developed in order to support this research in solving the problem statement (2.1). The tool is created with design criteria which emanated from the findings and issues from the cross-case analysis and theoretical framework. The so called ‘DRD-tool’ could be used to improve the execution of SRM in LIPs and support the activities. The theoretical model about SRM has been used as the base for the design and input variables from the components complexity and integrated contracts are added. The ‘DRD-tool’ has been developed in order to answer the following sub-question:

*What is the solution to improve the execution of SRM?*

The design criteria which emanated from the findings about SRM are: ‘a standard method to execute SRM’, ‘collaboration between client and contractor’ and ‘participation with stakeholders’. The design criteria which emanated from the findings about complexity are: ‘six practical complexities’, ‘prioritizing issues’ and ‘dynamic complexity’. The design criteria which emanated from the findings about integrated contracts are: ‘sharing risks and responsibilities’, ‘competency to deal with issues’ and ‘flexibility instead of strictness’.

The tool consists out of three main components. The first component is a step-based plan for the execution of SRM as stated in the theoretical framework and forms the base of the model. The eventual steps are slightly adjusted to match with the activities of the ‘DRD-tool’. The second component is used in order to quantify the responsibility division between client and contractor, which will eventually be stated in the third component. It consists of an ‘issue-complexity matrix’ and an ‘issue-competency matrix’ which should be filled out in consultation. The third component is a quartered ‘responsibility grid’ with two axes (contractor’s responsibility and client’s responsibility) that emanated from the first thought to solve the responsibility divisions. This grid should become the outcome of the tool, serving as an instrument to facilitate discussions between client and contractor. In this grid both client and contractor can visualize their responsibility for particular issues. Scoring issues according responsibility is done with the marks 0 to 10, which emanate from the second component.

**FEEDBACK MEETING AND ADJUSTMENTS**

The tool will be evaluated in a feedback meeting in the form of a workshop, in which three groups of two participants applied the tool on a topical case project: Nieuwe sluis Terneuzen. Therefore, the practicability of the tool is tested and the evaluation round will clarify if the tool can improve the current issues in executing SRM. This will lead to an answer to the following sub-question:

*How will the solution tool improve the current issues in executing SRM?*

At the end of this workshop the tool has been evaluated and possible improvements to adjust the tool were noted. Furthermore, possible adjustments and comments given by the supervisors of this research were taken into account to improve the tool. These adjustments led to the design of the final ‘DRD-tool’ (Desired Responsibility Division tool), which is visualized in Figure 24. An instruction manual is developed to take into account when the tool is used, including some important side notes.

**CONCLUSION**

The last chapter contains the conclusion (1) in which the research objective will be reached by answering all sub-questions and eventually the main research question:
What contributes in solving issues with complexity and integrated contracts in Stakeholder Relationship Management during Large Infrastructure Projects?

Several standard methods have been developed recently to structure SRM or support the tasks. A general structure which they have in common is a step-based plan. Increasing complexity and integrated contracts are seen as the main factors in causing issues for SRM. Detail- and dynamic complexity form the scientific structure and social-, technical-, organizational-, legal-, financial- and temporal complexity form the practical structure. The introduction of integrated contracts has the consequence that the responsibility division between client and contractor is changing. Much responsibilities are shifted to private contractors who must execute new tasks, including SRM. The static character of these contracts leads to discussions about responsibility divisions.

The respondents acknowledged that a standard method for SRM would be beneficial. Collaboration and participation were recognized as key factors for success in the case studies. Main issues arose with contractual changes and misinterpretation of agreements. All issues that occurred contained one or more of the six practical complexity types, although not every complexity was equally important. Next to the six complexities of the practical structure, dynamic complexity was recognized in the cases. All respondents from both client and contractor felt that at this moment too many responsibilities are shifted to the market. Responsibilities were strictly divided in all cases, but in some cases SRM managers shared responsibilities outside the contract. The main disadvantage as stated by all respondents is the lack of flexibility in integrated contracts.

These issues could perhaps be solved by applying the ‘DRD-tool’ in the execution of SRM during LIPs, with some important side notes. Both client and contractor should keep in mind that the values will visualize the desired responsibility division outside the contract and should be filled in accordingly. It should be checked afterwards if the desired responsibility division is also possible within the contractual boundaries. The ‘DRD-tool’ must not be seen as the solution, but as an instrument to facilitate discussions about the responsibility divisions.

RECOMMENDATIONS

Further development of the ‘DRD-tool’
Further development of the ‘DRD-tool’ can make it more applicable in practice, although it has been tested in practice by means of a workshop and several adjustments are already done. It is particularly important that further research should look into the link between the desired responsibility from the tool and the possibilities to implement this in the contractual agreements. Also a software program or excel plug in could be created to make the tool easier to use and digitalize the content. In this way the users do not have to fill out the tools manually every time they use them, which shifts the attention to the most important part: the discussion.

Create awareness for collaboration and participation in SRM
Collaboration and participation, or actually the lack of it, have been noticed as the most important findings in the execution of SRM in practice. Collaboration has been identified by the respondents of the case studies as one of the most important factors for project success. Nevertheless the current methods do not hold much information about these aspects. Participation with stakeholders is an activity in SRM which is mainly executed based on personal experience and initiative. Participation with stakeholders was seen by the respondents from five out of six case studies as inevitable to realize the LIP. Therefore more awareness in both fields could be created, to give collaboration and participation more prominent positions in the execution of SRM.

In depth research to add flexibility in integrated contracts
The literature about integrated contracts clearly stated that the more integrated a contract becomes, the more responsibilities are shifted to the private market. This causes that responsibilities are increasingly more divided between client and contractor. Intended freedom in design and execution is stated in theory as an important added value of integrated contracts. In practices the respondents actually experienced that the lack of flexibility is one of the main hurdles for the execution of SRM. Managers share responsibilities outside the contract in the current situation, because it was seen as inevitable in solving several issues. Therefore, more research could be done to examine if more flexibility can be added to integrated contracts.
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<td>Large Infrastructure Project</td>
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<td>SRM</td>
<td>Stakeholder Relationship Management</td>
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<td>Strategisch OmgevingsManagement (Strategic SRM)</td>
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<td>D&amp;C</td>
<td>Design &amp; Construct</td>
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<td>DBFM(O)</td>
<td>Design, Build, Finance, Maintain (Operate)</td>
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<td>QCA</td>
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<td>UVO</td>
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<td>Verzoek Tot Wijziging (amendment request)</td>
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<td>WOG</td>
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1. INTRODUCTION

This chapter elaborates the reason why this research is conducted and why it is relevant. At first an anecdote about an example case will create the image of the actual situation. Next the topic of this research and its components will be elaborated, to explain the content. The introduction ends with a reading guide and a visualization of the report components, to clarify the structure of this research.

1.1 ANECDOTE ABOUT THE DUTCH ‘MAVA’ PROJECT

A topical Dutch infrastructure project is the expansion of the highways A15 and N15 between the ‘Maasvlakte’ and the ‘Vaanplein’, with the nickname ‘MaVa’. The expansion project is executed near the city of Rotterdam in the most important economic region of the Netherlands. Next to the widening of 37 kilometers of road, the project entails the renovation of two road tunnels, 36 crossovers, a traffic control system, maintenance until the year 2035 and the construction of the highest lifting bridge in Europe (Houtemaker, 2015). The described trajectory is sketched in Figure 1, where the gray line represents the highway within an environment of several key infrastructural locations in the Netherlands.

The private contractor is the consortium ‘A-lanes A15’, including two large Dutch construction companies: Strukton and Ballast Nedam. Rijkswaterstaat (RWS) is the public client of this governmental infrastructure project. The organization is part of the ministry of infrastructure and environment, as the executive agency for Dutch governmental infrastructure projects. RWS awarded this project in 2011 based on a contract with a calculated ceiling price of 900 Million Euros. The contract includes the design, building, financing and maintenance of the project, with a life cycle of 25 years. The participating contractors in the procurement could win the tender by scoring on quality in one round and scoring on price in the other round. The consortium ‘A-lanes A15’ betted on a low price: 650 Million Euros, 250 Million beneath the ceiling price. The winning, but very risky move of the contractor was the proposal to take on all the ‘listed risks’. This was necessary because of the high competition and hard times in the construction industry due to the economic crisis. Examples of ‘listed risks’ are: soil conditions are contradicting with the map, unforeseen counteractive stakeholders or delays in permit requests. One ‘listed risk’ in this project requires extra attention: more than 1000 permits had to be requested from surrounding stakeholders (Houtemaker, 2015). The necessity to execute this project in difficult times for the construction industry made it inevitable to take on these risks, while it was not sure if the contractor alone was competent enough to manage these risks.

![Figure 1: Trajectory of the ‘MaVa’ project (Heeringa, 2015)](image-url)
During the construction phase the contractor faced many unforeseen circumstances in the complex environment, which worked adversely for the collaboration with RWS. Examples are: complaining residents and companies, or changing demands of actors like the Province or the Rotterdam port authority. These unforeseen events created dissatisfaction among stakeholders and caused that several required permits were not issued. RWS approved the design and left the permit responsibilities with the contractor as agreed. Although RWS was more competent to take on some ‘listed risks’, they did not help the contractor. The contractor was accounted for the occurred ‘listed risks’, which they necessarily had to accept. Therefore the project went 250 Million Euros over budget, while on the other hand the project is of good quality and almost within time. There are claims about the extra costs between the contractor and client, which makes their relationship getting worse. For example: RWS accuses the contractor of applying with a low price and ‘A-Lanes A15’ claims that RWS did nothing to support with the legal procedures in requesting permits (Houtemaker, 2015). It is suggested that RWS was more competent to take on several ‘listed risks’, or that the process would have went better if they at least collaborated on the issues. The responsibilities were divided according strict contractual boundaries, while another desired responsibility division could have been more beneficial for the project (Koenen, 2014).

### 1.2 SRM: ON COMPLEXITY AND INTEGRATED CONTRACTS DURING LIPS

The main component of this research is Stakeholder Relationship Management (SRM). The reason why SRM is the main component is because current developments in society, referred to as participation society, ensure that SRM gets a more important role in the Dutch construction industry. These developments cause that interaction with surrounding stakeholders is inevitable (Volkerinfra, 2015). Issues with SRM are key items in current media and the young existence makes it an underexplored discipline, which clarifies the relevance of this research (KING, 2010). SRM originated as a discipline in the working field of Large Infrastructure Projects (LIPs), which will therefore be the field in which this research is conducted (Visser, 2013). The other two research components are complexity and the introduction of integrated contracts, because these are assumed to be the main factors causing issues or developments in SRM (Verweij, 2015). This paragraph will introduce the three research components SRM, complexity and integrated contracts in LIPs.

### 1.2.1 LARGE INFRASTRUCTURE PROJECTS (LIPs)

The working field of LIPs is the research field in which this research is conducted. The main research component SRM occurs in this field, with complexity and integrated contracts as main influencing factors. LIPs are defined by scientists in this research field as: “projects which have to be developed to meet rising and changing demands for interregional and international mobility” (Hertogh, 2008, p. 16). The ‘Parliamentary Office of Science and Technology’ (POST) is a governmental organization of the United Kingdom, which calls these projects Major Infrastructure Projects (MIPs). The same project types are meant with both terms, while the ‘POST’ defines the projects as: “Large scale projects of national importance” (POST, 2002, p. 1). The rest of this thesis will use the term LIP to indicate these projects, because that is the most widely used expression in the Dutch construction industry. At any given moment around the world there are more than 200 large public or private capital investment projects executed, each worth more than $500 Million (Wyman, 2015). LIPs are in the Netherlands initiated by the government and executed by agencies for Dutch governmental infrastructure project, like RWS and ProRail. Government authorities like RWS, provinces or municipalities often come up with a problem to which private companies respond with a solution. A tender procedure determines which contractor is awarded with a contract to execute the LIP together with a public authority (Rijksoverheid, 2015). Examples of LIPs are: airports, ports, land reclamations, tunnels, bridges, railways, roadways and locks, which often cost several hundreds of millions of Euros. Characteristics of LIPs are (Flyvbjerg, 2005, p. 1):

- **Multi-actor processes with conflicting interests.** It is inevitable to construct a LIP without influencing the surrounding stakeholders, who have conflicting interests that should be managed.
- **Complex interfaces.** Complexity always has been present in LIPs, due to technical-, social- and other difficulties during the execution in complex environments.
- **Scope changes.** This are changes in the project boundaries due to changing demands or issues.
- **Incorrect allocating of profits and risks.** Risk and responsibility divisions are often underestimated or misinterpreted, which leads to issues in the collaboration.
- **Unusual or new technologies.** Unknown or new technologies can cause issues for contractors.
- **Long planning horizons.** These are caused by the long lifespan of LIPs which can be up to 40 years.
1.2.2 STAKEHOLDER RELATIONSHIP MANAGEMENT (SRM)

Only a few decades ago almost nobody had heard from the discipline SRM, but in the present construction industry it cannot be imagined that projects are executed without involving the environment. The discipline has been executed for centuries, but naming the term and stating the corresponding activities as a discipline is something of the past several years (KING, 2010). Since the introduction of SRM as a discipline, the issues during the execution are documented to learn from. Interests in the discipline SRM are growing and the importance is increasingly more acknowledged (KING, 2010). It is inevitable that a LIP has impact on the physical environment in which it is implemented and vice-versa. The interactions with involved stakeholders cause conflicting interests which can lead to bottlenecks and delays (Clafis, 2015). These difficulties always occurred during the execution of SRM, but there are two key components in the field of LIPs which are assumed to cause major issues in the current execution of SRM: increasing complexity and the introduction of integrated contracts. These issues first arose when the private market started to cope with the discipline SRM next to governmental agencies who already executed it (Projectburo B.V., 2015).

SRM can be structured in a practical and in a scientific way. The main goal of SRM in the practical structure is creating support among stakeholders for the execution of a LIP (Proflexis, 2015). This can be done through several activities in different construction phases. The characteristics of LIPs are causing conflicting interests between stakeholders and legislative procedures and new techniques bring complexities during the execution of construction projects (Clafis, 2015). Practical SRM activities can be found in all project phases of a LIP. For example: convincing stakeholders during the design phase to be in favor of the project should result in less delays and lower costs (VolkerInfra, 2015). Furthermore SRM is used in the execution phase to counteract problems with different stakeholders. Next to that flora and fauna, road blocks and nagging sub contractors are obstacles against which SRM should be used in order to prevent major delays. Also many changes occur in the construction industry during the maintenance phase and therefore adding flexibility to the contract is a practical SRM activity to keep up with the developments (Proflexis, 2015).

In this research the practical structure of SRM is divided in five working fields: stakeholder management, communication, participation, conditioning and traffic management (Rijkswaterstaat, 2009). The choice to divide SRM in this way in practice and explanations of the working fields are further elaborated in the literature study (3). Stakeholder management tasks were executed by the project manager in traditional contracts, but since the introduction of integrated contracts and increasing complexity the accompanied responsibilities are too advanced for one person. LIPs furthermore encounter increasing social developments, which causes that SRM takes more time than before and more working fields next to stakeholder management arise. Specially assigned stakeholder relationship managers now execute SRM to unburden project managers (Proflexis, 2015).

The scientific structure of SRM will be analyzed with process management. This is the scientific field in which the behavior of stakeholders, the effects of decision making, dynamic changes and management problems in these events are researched (ten Heuvelhof & de Bruijn, 2012). Stakeholder management is seen as the largest and most important practical working field of SRM. The scientific structure of SRM can also be found in this working field, which will therefore be more extensively elaborated under the name of process management. Substantive aspects of major changes, like with constructing a LIP in an environment, often have such complex characteristics that focused attention on process aspects is necessary. The involvement of all actors with an interest, between which disagreements can occur, is important for the change process because in this way they can recognize their views in problems and solutions (ten Heuvelhof & de Bruijn, 2012).

The young existence of SRM causes that several organizations have different views on the execution of the discipline in Dutch LIPs. For example, the governmental organization RWS has created a uniform standard to structure LIPs: Integral Project Management (IPM), in which SRM is accommodated (Rijkswaterstraat, 2012). Furthermore there are independent organizations which developed an approach to execute SRM. For example, Wesselink created an approach which solves issues in a reproducible way and builds on a sustainable relationship: Strategic SRM, or ‘Strategisch Omgevingsmanagement’ (SOM) in Dutch (Wesselink, 2011). These and other leading approaches on SRM will be elaborated in the literature study (3).
1.2.3 COMPLEXITY

Complexity in the working field of LIPs is assumed to be a main influencing factor in the execution of SRM. The attempt to implement a LIP has been recognized as a complex activity. The thought that such large scale projects would not have interaction with the existing surrounding social- and physical systems, is very naïve. This leads to complexity, which is therefore one of the main reasons for failing projects (HM Treasury, 2012). The difficulty of complexity is that it occurs unforeseen and unplanned. Lessons should be drawn from good and bad experiences, to improve future LIPs (Verweij, 2015).

Complexity has always been present in LIPs. However, current social-, technical- and other developments in society are causing much increasing complexity in the past several decades. In trajectories with dozens of kilometers of tunnels, bridges and more civil works, technical complexity has a major impact on the environment. Next to that, the increasing social complexity of surrounding stakeholders has an influence on the project as shown in Figure 2. In this picture an integrated contract between a governmental client and a private contractor is shown, with the relations between the accompanying stakeholders. This complexity is caused by unforeseen events which are difficult to recognize (Verweij, 2015). Because of the long lifespan of LIPs with integrated contracts, dynamic changes over the years are a certainty. The contractor has to respond to the changing demands and wishes of the client and surrounding stakeholders during the project, while the contract is static (Hertog & Westerveld, 2009). In traditional contracts the contractor’s responsibility according SRM was limited to informing stakeholders about the project: ‘building communication’. The contractor now has to deal simultaneously with several complexities. The vision of SRM by the contractor states that there is insufficient participation with surrounding stakeholders in the current situation (VolkerInfra, 2015).

A leading country in the research on successful delivering of LIPs is the United Kingdom. The ‘HM Treasury’ together with the ‘Infrastructure Client Group’ are trying to discover the value of effective collaboration between government and industry to improve the delivery of LIPs. This is done with the application of a tool in practice. What they found was: “striking patterns in the reasons for projects failing, which all related to the importance of understanding the delivery environment and complexity of the project when making a decision whether to proceed” (HM Treasury, 2014). This clarifies that the lack of understanding complexity and the context in which LIPs are executed are very important in project failure. The tool to consider challenges, complexity and risks for delivering projects is the ‘Delivery Environment Complexity Assessment’ (DECA) tool (HM Treasury, 2014) and will be further elaborated in the literature study (3).

There are different schools of thought which have described complexity in LIPs in the last couple of years. Baccarini (Baccarini, 1996) formulated the first complexity concept as ‘organizational’ and ‘technological’. Williams (Williams, 2002) followed next with ‘structural’ and ‘uncertainty’. Geraldi (Geraldi, 2008) talked about ‘fact’, ‘belief’ and ‘interaction’ as complexity in projects. Remington and Polack (Remington & Pollack, 2007) furthermore described complexity as ‘structural’, ‘technical’, ‘directional’ and ‘temporal’. In 2009 Hertog and Westerveld conducted a research to manage complexity in LIPs, which is called: Playing with complexity (Hertogh & Westerveld, 2009). They combined the theoretical viewpoint from the different schools of thought with the practitioners’ point of view and divided complexity in a practical- and scientific structure. The scientific structure consists of ‘detail-’ and ‘dynamic complexity’ and the practical structure consists of ‘social-’, ‘technical-’, ‘organizational-’, ‘financial-’, ‘legal-’ and ‘time complexity’. Despite various perceptions in these descriptions, the different schools faced the same issues with complexity in LIPs. It is important to create a set of variables about complexity in LIPs, which covers all literature (Dunovic, Radujkovic, & Skreb, 2014). Therefore the development of complexity throughout history is stated in Appendix A: Additional elaboration on the literature. The structure of complexity which eventually will be used for the rest of the report will be elaborated in the literature study (3) (Hertogh & Westerveld, 2009).

Increasing complexity in LIPs is caused by its previously named characteristics (1.2.1). The characteristics can be linked to the practical- and scientific structures of complexity. For example: scope changes can be linked to dynamic complexity, multi-actor processes with conflicting interests can be linked to social complexity and unusual technologies can be linked to technical complexity (Hertogh & Westerveld, 2009).
1.2.4 INTEGRATED CONTRACTS

In addition, the introduction of integrated contracts in LIPs cause an ongoing shifting of project responsibilities and risks between the government (client) and the market (contractor). Integrated contracts are introduced due to a revolution in the market approach by the government. This revolution ensures the shifting of responsibilities to the market, under the concept: ‘markt, tenzij’ (‘market, unless’) (Nijpels, 2011). The movement from traditional contracts to integrated contracts resulted in broader definitions of tasks and responsibilities for the contractor (Projectburo B.V., 2015). The introduction of these contracts in LIPs have brought new difficulties, which have major influence on the practical execution of SRM in the Dutch construction industry (Volkerinfra, 2015). Therefore the introduction of integrated contracts is, together with increasing complexity, assumed to be one of the main influencing factors of issues in executing SRM.

Integrated contracts replaced traditional contract forms, in which different construction phases with associated responsibilities are strictly separated. In integrated contracts at least the design and build phases are combined in more extensive contracts and other building phases like maintenance and operate can be added. These contract types have been implemented in the Dutch construction industry since several decades. Because of the short existence it is hard to speculate about the performance of these contracts (Verweij, 2015). Integrated contracts entail that public- and private responsibilities are separated, dividing the tasks. This causes issues for contractors, who executes tasks for which clients could be more competent, or for which collaboration is more beneficial (Rijkswaterstaat, 2015). The contractor being responsible for the design of LIPs in integrated contracts is the biggest difference with traditional contracts. Design decisions taken by the client are shifting to the contractor in a gradual manner. Since the introduction of the UAV-GC 2005 as the successor of UAV ‘89, responsibilities are increasingly shifted to the contractor (Projectburo B.V., 2015). The extra freedom and responsibilities for the contractor resulting from this movement brings new tasks for the contractor compared to traditional contracts. One of these new tasks is the main component of this report: SRM (Visser, 2013).
The main motive of governmental authorities for implementing integrated contracts is that they should have added values in the fields of private financing, risk-shifting and long term collaboration, compared to traditional contracts (Verhees et al., 2015). In practice, these added values carry underlying tensions that could overrule the intended added values. The e-journal ‘BeleidsonderzoekOnline’ published an article about the tense relationship between public- and private partners in the construction industry (Verhees et al., 2015). The following intended added values of integrated contracts and their corresponding underlying tensions have been extracted from several case studies (Verhees et al., 2015, p. 1):

- An integrated contract implies a balance between private risks and responsibilities in the ‘BFM’-phases of a project and private freedom and innovation in the design phase. Tension is possible between this private freedom in the design phase and the spatial laws and legislation of institutions. The Netherlands is very densely built with strict legislation, which limits freedom and innovation.

- Risk division in integrated contracts should proceed according risk management: the partner with the most competence to manage a risk takes it on. Tensions could arise when the client has the power to push most risks to the contractor, because there is much competition on the private market.

- Because of the Finance component (only applicable for DBFM(O) contracts) in integrated contracts, private financers (banks) become allies of the public client. Tensions arise when this interest clashes with the interests of the private consortium according budget and time pressure.

- Integrated contracts create a long term collaboration between client and contractor, mainly based on the contract. Tensions can occur between the term ‘collaboration’, which is based on trust and the term ‘contract’, which is usually based on distrust. In the current situation all details are fixed in the contract, suggesting there is no room for freedom and flexibility which are based on trust.

- Integrated contracts, a commitment between two organizations, have the character to enforce the participation between both partners. Tension comes however from external stakeholders, who want to have, or have large influence on the project. These stakeholders are overlooked by the project organization instead of letting them participate.

- A long term integrated contract implies room for flexibility, because changes in the environment are certain to happen in such planning horizons. The tension comes from the integrated contract types, which are focused on fixation, although changes are inevitable.

An additional characteristic of integrated contracts, is that separate engagement instead of collaboration is enforced. This creates tensions in specific contractor or client tasks, where collaboration would have been more beneficial for the project. These tensions occur for example if permits have to be issued by external stakeholders to be able to continue the construction. External stakeholder do not feel obliged to distribute permits to a private contractor, which can cause project delays (Koenen, 2014). Integrated contracts are not flexible when they state that the responsibility to request permits lays with the contractor, although for obtaining some permits the client is more competent. These tensions lead to cost overruns and delays, which eventually lead to accusations between client and contractor about who is to blame for the corresponding mistakes (Wassenaar, 2015).

Examples of integrated contracts are Engineering and Construct (E&C), Design and Construct (D&C), Design, Build & Maintain (DBM) and Design, Build, Finance, Maintain and Operate (DBFM(O)). These examples are further elaborated in the literature study about the structure of integrated contracts (3.3.3). An integrated contract type which has been introduced in the past several years needs extra attention: DBFM(O) contracts. In these contracts the contractor delivers a service throughout the whole lifecycle of a LIP. When the central government works with a PPP, they mean a DBFM(O) project. Besides the central government also smaller governmental organizations like provinces and municipalities can use a PPP. Despite this view of the central government, also other integrated contracts can be used in PPPs (Rijksoverheid, 2015). It is therefore necessary to look into different definitions about integrated contracts in the literature study (3.3).

The contractor who has to execute the project, often organized in a consortium, is chosen by means of a tender procurement. In the Netherlands, the client can pick the design of a contractor by means of two awarding criteria: Lowest price or Economically Most Advantageous Tender (EMAT). Since April 2013 the Dutch law obligates the client to use EMAT, unless they prove that awarding by means of lowest price is more advantageous (Hardeman, 2013).
1.3 READING GUIDE

In this chapter the topic of this report has been introduced and the reason why this research is conducted was given. Furthermore the three components of this research topic (SRM, complexity and integrated contracts) have been introduced. The research design will be explained in the next chapter: chapter 2. The problem definition will summarize why this research is conducted from the introduction and the objective states what the goal of the research is. The scope defines the boundaries in which the research is executed and the relevance names the values of this report. The research questions and methodology, will explain how the goal will be reached and with which methods.

After that, chapter 3 contains a literature study about the three components: SRM, complexity and integrated contracts. For each separate component a definition or explanation is given and a structure is created out of different literature. This leads to one general theoretical framework in paragraph 3.4, by combining the three components, which will be used as theoretical input for the solution tool. Chapter 4 contains the case study researches, which are executed through data analyses and interviews. At first the reason why case studies are used and how they are used for this research is elaborated in the case study methodology (4.1). After that the results of the six executed case studies are given. Paragraph 4.8 contains a cross-case analysis between the cases to compare the different outcomes with each other. The last paragraph of the case study research gives a conclusion and states the most important findings about the case studies.

The next step is to compare literature and practice in chapter 5, to develop a solution which will be conceived in the form of a tool. The tool must become a solution for the formulated problem statement. Findings from the theoretical framework and cross-case analysis form the design criteria for the tool. After that, an evaluation will be created in chapter 6, which will be done by organizing a feedback meeting in the form of a workshop, by applying the tool on a different case. The tool will be adjusted according the feedback from this meeting. The last part of this research consists of conclusions and recommendations in chapter 1. The most important findings from this research and recommendations for future research will be given. This reading guide is also visualized in paragraph 2.7: thesis outline. Figure 3 shows how the three research components of this research come together to the focus of this research in the field of LIPs.
2. RESEARCH DESIGN

In this chapter the research design of this master thesis will be elaborated. The first paragraph states the problem definition and therefore declares why this research is conducted. This is a summary of the elaborated problem in the introduction. The second paragraph contains the objective, which states the goal of this research. After that, the scope defines the boundaries in which the research is executed. Furthermore, the relevance of this research declares the scientific- and practical applicability of the possible outcome. The fifth and sixth paragraph contains research questions and the methodology, which explain how the goal will be reached and with which methods. The last paragraph states a schematic view of the outline of this thesis.

2.1 PROBLEM DEFINITION

Implementing a LIP in physical environments inevitably has large impact on its surroundings. On the other hand, the surroundings influence the execution of a LIP. The interaction with involved stakeholders leads to conflicts, which causes issues during LIPs (KING, 2010). These issues always occurred during the SRM activities, but since SRM is recognized as a discipline the issues are found and solutions are sought. Current developed methods are relatively new and therefore not much can be said about the performance (Verweij, 2015). The contractor has to deal with all these growing issues in the field of SRM, while the discipline is a new working field for them (VolkerInfra, 2015). Therefore the problem definition of this master thesis arose from the issues that VolkerInfra encountered with the new discipline SRM and the search for a solution to these issues.

Complexity always has been present in the working field of LIPs, but due to the rapid developments in society complexity is increasing very fast. LIPs are getting increasingly complex in practical and scientific ways (Hertogh & Westerveld, 2009). For example: technical complexity arises with innovative technologies and increasing dynamic complexity causes scope changes during the long life cycle of a LIP (Verweij, 2015). In addition, the introduction of integrated contracts cause changes in the risk- and responsibility division between client and contractor. Tensions instead of the intended added values arise with the implementation of these contracts (Verhees et al., 2015). For example: intended freedom and innovation in the design phase are suppressed by strict legislation and the finance component causes time pressure, because delays lead to high interest costs.

Risks are pushed to the responsibility of the private market, while the contractor is not always the most competent organization to take on the risk. The contract also creates a strict boundary between public and private responsibilities, while intended long term collaboration suggests the opposite (Projectburo B.V., 2015). Therefore the following problem statement merges the three interacting components of LIPs in one sentence:

Problem statement
The execution of SRM is a fairly new discipline with two main influencing issues: firstly, the increasing complexity in LIPs and dynamic changes make SRM harder to execute and secondly, the introduction of integrated contracts cause tensions for SRM instead of having the intended added values.

2.2 RESEARCH OBJECTIVE

The objective of this research is to improve the current situation in executing SRM, with complexity and integrated contracts as the main influencing factors. The approach to find out the current situation and issues is divided in two parts. At first theories about SRM, complexity and integrated contracts are elaborated in a literature study. Secondly, several case studies will be used to compare the theory with practice. The main goal of this research is to create a solution tool, or part of it, to solve the problem statement. The objective is a combination between researching and designing with the three research components: SRM, complexity and integrated contracts. The responsibilities between client and contractor are the main perspective of the research, but external stakeholder responsibility will also be researched. This research is aimed towards a recommendation in which the solution tool is the central thought to support SRM in constructing LIPs.
Research objective

*Understand current issues on complexity and integrated contracts that influence SRM and develop a solution to improve the execution of SRM in LIPs.*

### 2.3 RESEARCH SCOPE

SRM is a very broad research field, which has many elements to investigate, because it is a young discipline. Because this research is limited to several months, the scope focuses on a clear section of SRM. The core content of this thesis is formed by the execution of literature- and case study researches. The literature and the cases which are researched must be framed within the boundaries of the report. Therefore, the scope of this research will have the following boundaries in which a solution for the problem statement must be found:

- The geographic boundaries are defined by the Dutch borders. The research is executed in the Netherlands with practical examples, which makes it easy to get real access. Therefore, Dutch building legislation about LIPs will be used as the guideline.
- The focus will be put on Dutch LIPs with integrated contracts, for example a DBFM or D&C contract. The researched LIPs must have integrated contracts, because the core problem (2.1) occurs in integrated contract types.
- The investigated period of LIPs are the project phases up to and including the building phase. This includes the plan-, design- and construct phases, in which all preparation and execution is done. In these phases SRM is executed the most intensively, because during the maintenance phase the involvement of surrounding stakeholders is minimal (Volkerinfra, 2015).
- The research topics are SRM, complexity and PPPs, because these are identified to be the main issues in executing SRM. Complexity is split up in two structures, with six practical complexity types as one structure and two scientific complexities as the other structure (Hertogh & Westerveld, 2009).
- The research field is limited to projects which are being, or have been, executed within the VolkerWessels organization. This research is executed under the supervision of VolkerInfra, which makes it easier to get in touch with the corresponding managers responsible for SRM in the case projects. Therefore, it is possible to get more information in the few available months for the research.
- The perspective of this research will be from an objective viewpoint. Although this research is conducted for VolkerInfra, which is a contractor, an objective viewpoint will create a more accurate result. Issues from all sides must be revealed to come up with a good solution tool for the problem statement, which is applicable for every SRM manager.
- The research approach is from both contractor’s (VolkerWessels) as well as the client’s (governmental organizations like municipalities, RWS or ProRail) view on SRM. Both public client and private contractor are intensively engaging in SRM. Managers from both sides will be interviewed, but more external stakeholders are excluded because of a lack of time.

### 2.4 RELEVANCE OF THE RESEARCH

**Academic applicability**

In the Netherlands SRM already has one word which defines the discipline: ‘omgevingsmanagement’, where other countries do not have a word to name the discipline. Because integrated contracts have a young existence in the Dutch construction industry and the long lifespan LIPs, not much can be said about the performance of the projects. Large contractors in the Netherlands are coping with the shifting of the responsibilities and risks. They are inexperienced in SRM because it is a task which is only executed by the contractor since a few years. Therefore, this research contributes to explore the research field of LIPs and helps to create new insights in the discipline SRM. Combining and comparing different literature and practical experiences should lead to developments for the execution of SRM. This research aims next to the contribution of knowledge about SRM, to have added academic value in the research about the main issues in the working field: complexity and integrated contracts. The methodology to structure the three components and eventually to form a solution tool can be seen as an academic approach.
Practical applicability
Currently failing infrastructure projects give rise to very actual items in the media, like the ‘MaVa’ case example in the introduction (1) (Koenen, 2014). Therefore, this research can be of practical use in the search of understanding the issues of SRM, especially with responsibility division in integrated contracts and increasing complexity in LIPs. For the literature- and case studies is chosen to gather information about SRM, complexity and integrated contracts in different types of LIPs. Complexity and integrated contracts are the main difficulties of SRM in the current LIPs. The objective of this research is to create a solution tool which will support the current tasks of SRM and can be used in practice. A possible tool can be a responsibility model which indicates if different types of issues should be engaged by the public client, by the private contractor, together, or with participation of external stakeholders. Different types of complexity will create the possibility to rank the SRM issues. The solution tool will be tested and evaluated in the end to see if it can be used in practice.

2.5 RESEARCH QUESTIONS
In order to reach the desired objective, a main research question is formulated. The research question will be answered throughout the chapters of the report with several sub-questions, which all cover an element of the main topic. In the end answering all research questions will lead to the solution for the problem statement. The main research question is formulated as follows:

Main research question
What contributes in solving issues with complexity and integrated contracts in Stakeholder Relationship Management during Large Infrastructure Projects?

The first part of the question makes sure that the findings of this research should result in a solution to improve current issues. The second part assures that information must be gathered about these current issues in the three research component of this report: SRM, complexity and integrated contracts. The last part defines that the working field of LIPs is the research field in which this research is conducted.

Sub-questions will support the main research question throughout the report in the following specific order, to keep the research structured:

1. How can SRM, complexity and integrated contracts in LIPs be defined and what do they entail?
By means of a literature study the current theory about the three components in LIPs will be given. Definitions and content about SRM, complexity and integrated contracts in LIPs are elaborated with different literature. The findings will be combined to come to a theoretical framework of the current approach. This will be a model of the current SRM approach with two sets of variables from complexity and integrated contracts.

2. How are SRM, complexity and integrated contracts approached in practice?
This question will be answered with a practical approach. By means of case study researches about six Dutch LIPs, issues according the three components are researched. The theoretical framework forms the basis for the interview questions, which will be asked to interviewees from both the client and the contractor of every LIP. In the end of the case study research a cross-case analysis will compare the findings of the case studies.

3. What is the solution to improve the execution of SRM?
The findings and issues from the cross-case analysis and theoretical framework will create several design criteria. These criteria from the three research components will lead to the development of a solution tool. The tool should be used to support the SRM activities and will contribute in solving the current issues with complexity and integrated contracts during the executing SRM.

4. How will the solution tool improve the current issues in executing SRM?
A feedback meeting in the form of a workshop with key stakeholders will contribute to test the applicability on a case and adjust the solution tool afterwards. After that recommendations will state possible improvements for future research and things that could have done differently.
2.6 METHODOLOGY

The research body of this thesis consists of four different steps to answer the research questions. At first a literature study is conducted, after that several case studies will be executed, furthermore a solution to the given problem will be created and in the end a feedback meeting is used to evaluate the solution. The literature study will give a better theoretical insight in the current theories about SRM, complexity and integrated contracts in the field of LIPs. The case study researches will give a practical insight on how complexity and integrated contracts affect SRM in practice during LIPs. The solution in the form of a tool will arise from a theoretical framework at the end of the literature study and a cross-case analysis at the end of the case study research. The evaluation meeting will give feedback on the practicability of the created solution tool, by means of a workshop. The created tool or model will be adjusted according the remarks of the experts and compared with the old situation, which will lead to recommendations for further research as the research output.

2.6.1 LITERATURE STUDY

A literature study (3) is the second step in the thesis outline (2.7), after the introduction. The literature study (3) will give a better theoretical insight about SRM, complexity and integrated contracts in LIPs. Therefore, it is divided in these three topics. Existing literature about these topics in the domain of infrastructure will be elaborated in order to get a better understanding about the research fields. The choice to divide this research in three topics comes from the problem definition. This research started with the search for issues in the current approach to execute SRM. It turned out that the increasing complexity and changing responsibility division in LIPs were the major difficulties. Therefore, the literature study is divided in three parts: SRM is researched to learn about the issues of the current executed approaches, complexity is researched to learn about the current complexities in LIPs and integrated contracts are researched to find out the current issues with responsibility division. The existing literature about SRM, complexity and integrated contracts is the input for a theoretical framework. This framework is a model with a set of variables, which will be tested by means of interviews in the case study research and forms the theoretical input for the solution tool. The three topics are researched in the literature study and related in the following way:

- Figure 3 at the end of the introduction shows the three components and their interrelations, with SRM indicated as main component in orange. The orange spot is situated in the middle of a larger beige field, which represents the field of LIPs. SRM will be researched to find out what the discipline entails and how it is currently applied in LIPs. This will be done by first creating a general definition from different resources and after that elaborating the practical- and scientific structure of SRM.

- Complexity is one of the two influencing components of SRM and is indicated in Figure 3 with a grey spot. The grey spot is partly situated below the orange spot of SRM, to indicate that it influences SRM. The complexity spot is also situated in the larger beige area, which represents the field of LIPs. Complexity will be researched to get to know the current issues due to complexity in LIPs. This will be done by first creating a general definition and after that elaborating the structure of complexity. This component is also divided in a practical structure and a scientific structure, just like SRM.

- Integrated contracts is indicated in Figure 3 with another grey spot, which represents the second influencing component of SRM. This grey spot is also situated below the orange spot, to indicate it influences the main component, like SRM. The spot is also part of the beige field that represents LIPs. Integrated contracts are researched with the focus on the responsibility division between client and contractor in those contracts. This is done by first describing what integrated contracts are and after that the different types and responsibility division is described.

- A theoretical framework at the end of the literature study consists of a general model with a set of variables. This framework is the researcher’s interpretation of the findings from the literature studies and will be used as a guide to test the practical approaches to the literature. The framework will also consist of three parts: a model from the literature about the current approaches to execute SRM and two sets of variables from the literature about complexity and integrated contracts. The white spot in Figure 3 is called the focus of the research and can be seen as the theoretical framework.
2.6.2 CASE STUDY RESEARCH

The case study research (4) is the third step in the thesis outline (2.7), after the literature study and introduction, which will give practical insight in the three research components. The first paragraph will elaborate the used method and the way in which data is gathered to create input for the intended solution: a tool to support SRM. In order to create a case study research the following literature is used: (Yin, 2009) ‘Case study research, design and methods’, (Swanborn, 2010) ‘Case study research, what, why and how?’ and (Stake, 1994) ‘Qualitative case studies’. A general definition of the term case study research will be extracted from these resources. After that, the added value of case studies in this research will be elaborated. Furthermore, the selection of the cases and used protocols for the interviews and data collection in the cases is explained.

In the second (4.2) until the seventh (4.7) paragraph of the case study research the results of the case studies are elaborated. The information from the six cases which are researched will be treated through data analyses and interviews. For all six case studies at least one respondent from the client and one respondent from the contractor has been interviewed. The interview protocol and interview reports are elaborated in Appendix D: Interview protocol and Appendix E: interview reports, but these are only stated in the confidential report. Every case study research is concluded with a set of important findings, which are used in the cross-case analysis. Collecting the case study results is called explanation building (Yin, 2009).

The last paragraph contains the cross-case analysis (4.8), where the case study results are compared with each other. The cross-case analysis will be used as data analyzing technique through several comparisons (Yin, 2009). The results from the explanation building are used as input for the cross-case analysis. Six cases have been chosen, because the analysis is more superficial with multiple case studies. The outcome of the cross-case analysis should form general data on the current issues within the discipline of SRM in LIPs and opportunities to enhance the situation. The elaborated cross-case analysis can be found in Appendix F: Cross-case analysis. The similarities and differences between the cases will be elaborated and a summary of the cross-case analysis is stated in Table 3, Table 4 and Table 5. Furthermore a literature review is given, which compares the findings of the cross-case analysis with the literature study (3). The cross-case analysis is concluded with the main findings, which form the input for the design criteria of the solution tool (5).

2.6.3 SOLUTION IN THE FORM OF A TOOL

After the case study results are analyzed and compared with the theoretical framework from the literature study, a solution will be conceived in the form of a tool. This solution tool (5) is the fourth step in the thesis outline (2.7) and must solve the formulated problem statement (2.1). The tool will be created with design criteria from the concluding findings of the cross-case analysis. This will lead to a plan or model, with the inputs from SRM activities, complexity and integrated contracts. The tool should be used to support the execution of SRM tasks in LIPs. The current theoretical framework will be examined and the discovered issues and findings in the current situation must lead to a new improved model, which can be used in the future.

2.6.4 FEEDBACK MEETING AND ADJUSTMENTS

After the solution is made, the next step in the thesis outline (2.7) is to organize a feedback meeting in the form of a workshop. Some participants are important stakeholders because they were also contact persons for the interviews in the case studies, but there will be also participants who will be confronted with the research for the first time. They will be participating in a workshop based on an existing case, on which the tool will be applied. The workshop will lead to discussions about the tool, which will be used to adjust it. At the end of this meeting the tool will be evaluated and the participants can give suggestions. The executed workshop can be found in Appendix G: Tool Workshop, nieuwe sluis Terneuzen and the adjusted final solution tool in chapter 6.

2.6.5 RECOMMENDATIONS

After the feedback meeting, the recommendations will be made. Some improvements for future research in this field will be given and things that could have done differently in this thesis will be addressed. Also an advice will be given according the applicability of the tool in practice. This is the last step in the thesis outline (2.7), which is visualized in Figure 4.
2.7 THESIS OUTLINE

- What is the scientific relevance? (introduction)
- Why is the research conducted? (problem definition)
- How will the research be conducted? (methodology)
- SRM definitions and structure
- Complexity explanation and structure
- Integrated contracts explanation and structure
- Theoretical framework
- How are case studies conducted? (Yin, 8)
- LIP cases
- Case studies (Chapter 4)
- Solution (Chapter 5)
- Evaluation (Chapter 6)
- Conclusion (Chapter 7)
- Literature results
- Tool/Model
- Feedback/adjust
- Applicability
- TU Delft (How)
- Articles/Reports (What)
- VolkerInfra (Why)

Figure 4: Thesis outline
3. LITERATURE STUDY

The first paragraph of the literature study will elaborate the importance, an explanation, current structures and approaches about the main research component: SRM in the field of LIPs. The second paragraph will state the importance, explanations and structures of the second research component: complexity in LIPs. The third paragraph clarifies the importance, explanations and structures of the third research component: integrated contracts. The last paragraph will combine and compare all definitions and structures of the three components to create a theoretical framework about the current theory about SRM, complexity and integrated contracts. Additional information on the theory can be found in Appendix A: Additional elaboration on the literature.

3.1 STAKEHOLDER RELATIONSHIP MANAGEMENT

This paragraph covers the literature study on the main component of this report: SRM. At first the reason why the literature study about SRM is necessary for this research is explained. This is done by repeating the importance of issues in SRM from the problem definition and elaborate it some more. After that a section will be dedicated to create a general definition of SRM from different literature. The section after that elaborates the structure of SRM and another section will state some currently used approaches for SRM. In the end a conclusion will finish this first literature study, which will be the input for the theoretical framework.

3.1.1 THE IMPORTANCE OF RESEARCHING SRM

The activities which are covered by SRM have always been difficult to execute and caused issues during LIPs. Since the introduction of SRM as a discipline, difficulties and issues at executing SRM are documented. The importance of SRM as a discipline is acknowledged since several years and therefore it is the main component of this research. (KING, 2010). It is inevitable that a LIP has impact on the physical environment in which it is implemented and therefore SRM has become one of the main disciplines in constructing a LIP. The interaction with involved stakeholders cause conflicting interests which can lead to bottlenecks and delays (Clafis, 2015). In the Dutch construction industry SRM is accumulated in one word: omgevingsmanagement (VolkerInfra, 2015). Although the word is circulating within the discipline, it is not yet defined in dictionaries and it is not clear whether this is the best definition of the discipline. Because SRM is a discipline which exists only several years in the construction industry, a proper definition has to be found to describe the field of SRM in construction.

The main reasons why stakeholders should be consulted or engaged are (Asian Development Bank, 2007):

- The lack of consultation or communication with stakeholders creates unforeseen opposition against the project, which can result in delays or cancellation.
- Even if the contract is awarded, the lack of stakeholder support can increase risks, because a lack of trust in the sustainability of a PPP.
- The input of stakeholders can be of much value for the design and practicality of a project. Allowing stakeholders to come up with their visions often creates an innovative approach.
- A broad understanding and support of a large public makes politicians willing to stay committed.
- Spreading information leads to an increase in credibility of stakeholders because they feel involved.

3.1.2 EXPLANATION OF SRM

Several definitions about stakeholders, stakeholder management and SRM from different perspectives are elaborated in Appendix A: Additional elaboration on the literature. One general description is distilled, which will be used as main description of SRM in the construction industry in the rest of this report. What all definitions have in common, but from different perspectives, is the involvement of surrounding stakeholders in a project. Also, taking into account the demands and wishes of these surrounding stakeholders is a returning understanding in all definitions. The shared purpose of SRM is creating activities which are aimed at involved stakeholders, to align interests for realizing shared goals. Therefore, the definition of SRM in the construction industry for this report is: “The involvement of all relevant stakeholders in a project and alignment of contradicting or supporting demands and wishes to reach shared goals” (Heeringa, 2015). SRM is approached differently in practice compared to academic sciences, especially in stakeholder management. Therefore, the structure of SRM will be divided in a scientific- and a practical structure, were the scientific structure is mainly explained with stakeholder management.
3.1.3 STRUCTURE OF SRM

At first, a general structure of SRM will be elaborated according different explanations of varying organizations. After that, the practical structure of SRM will be elaborated as executed by several governmental- and private organizations. All organizations divide SRM in several working fields in practice, to structure it and get an overview of the activities. These working fields will be explained more extensively in Appendix A: Additional elaboration on the literature. Furthermore, the scientific structure of SRM will be clarified with stakeholder management. This is the most important working field were issues arise and were different sciences are devoted to, like process management (ten Heuvelhof & de Bruijn, 2012).

SRM structure in several prominent organizations

The governmental organization RWS created its own structure to divide SRM tasks between managers. The used approach is called the IPM (integral project management) model, which has become the standard in infrastructure projects. Next to the IPM model (elaborated in paragraph 3.1.4), RWS divides the practical activities of SRM over five working fields. The following five working fields cover the practical structure of SRM: stakeholder management, communication, participation, conditioning and traffic management. Stakeholder management is the main field of SRM, because it covers the main goal: involving of surrounding stakeholders with their contradicting or supporting demands and wishes to realize shared goals. It is the unifying factor within the working fields. Several sources mention four fields within SRM, excluding the field participation. This field has some similarities, but also differences compared to the other fields. Therefore it is important to describe participation as a separate working field in SRM. The SRM manager should always be critical in terms of openness and information exchange in all above named fields. A reflection on the process in every project phase is important to keep everyone on topic. Every project phase and every important stakeholder needs fitting attention, which requires the SRM manager to be adaptive and flexible (Rijkswaterstaat, 2009).

The structure of SRM explained by the municipality of Amsterdam shows similarities with the structure which RWS uses. To execute the project according to the demands and wishes of the client as agreed in the planning, there are several steps which have to be executed in advance. Pipes and cables need to be relocated, juridical procedures in the field of urban planning should be executed, redirections have to be discussed with several stakeholders, etc. The following working fields form the structure of SRM to prepare and execute such tasks: stakeholder management, communication, conditioning and traffic management. Compared with the structure of RWS this organization excludes participation, but the activities of that working field are in this literature placed within stakeholder management. (Haak & Wanningen, 2013)

According to SBRCURnet, which is a knowledge network for the real estate sector, SRM consists of four elements: stakeholder management, communication, conditioning plus traffic management and collaboration with the client. Just like RWS and the municipality of Amsterdam, SBRCURnet divides SRM in several fields. The difference between the fields stated by RWS and SBRCURnet is collaboration instead of participation. They will be merged in the working field participation for this report, because participation is expected to be a very important factor which influences SRM. Stakeholder management is focused on being visible and accessible for the environment and safeguarding of agreements made with several stakeholders. Communication focuses among other things, on handling complaints and organizing consultation meetings with the neighborhood. Conditioning plus traffic management ensures that the building execution proceeds according to public guidelines for building in public places. Collaboration with the client entails making agreements with the client about tasks and responsibilities and maintaining them (SBRCURnet, 2014).

Practical structure of SRM

Taken the practical structures of several prominent organizations which are experienced in executing SRM into account, it can be said that there are a lot similarities. They all divide SRM in several, generally the same, working fields. Stakeholder management, communication and conditioning are the basic working fields which are covered by all organizations. Participation and traffic management are not always seen as working fields of SRM. There are multiple organizations which have different methods for structuring SRM, because there is no standard yet. The practical working fields are summarized in this section. A more extensive elaboration of the working fields can be found in Appendix A: Additional elaboration on the literature.
• **Stakeholder management.** This is the search for common goals, compromises and compensating measures, together with surrounding stakeholders including public organizations. This also means the ensuring the acceptation of the project result (Haak & Wanningen, 2013).

• **Communication.** This field concerns not just the internal communication within the project organization, but also the communication with external stakeholders (Bolle, 2008).

• **(Public) Participation.** Decisions improve when surrounding stakeholders share their ideas and interests which should be taken into account in the choices of managers (EPA, 2015).

• **Conditioning.** This is the working field of SRM which concerns making physical planning and juridical interference possible and makes sure that the building site is clear to execute the project (Haak & Wanningen, 2013).

• **Traffic management.** Accessibility, livability and safety around the building site are responsibilities of the SRM manager. All traffic has to be guided around the activities (Rijkswaterstaat, 2009).

**Scientific structure of SRM**

RWS describes four accents of SRM in a research during the four phases of a LIP, although these accents cannot be dissociated. During the exploration phase (understanding the problem) ‘strategic relationship management’ is the present accent. This implies maintaining strategic contacts with important network actors, focused on the matching of interests and intentions. After that, during the plan study phase, ‘area-specific collaboration’ is the influencing accent. This includes elaborating the preferred solution of RWS into a realistic plan, together with the surrounding stakeholder environment. Furthermore, in the execution phase, ‘project-stakeholder management’ is the present accent of SRM. This is the creation of physical and social conditions in order to achieve a manageable and defined project. After completion, during the maintenance phase, ‘public-oriented network management’ is the last influencing accent of SRM. This implies acting like an approachable network manager, who is sensitive for signals from stakeholders (Rijkswaterstaat, 2009).

As stated by de Bruijn and ten Heuvelhof in ‘Management in Networks’ (ten Heuvelhof & de Bruijn, 2012), stakeholder management can be described with actor networks and decision making processes. To realize policies or strategies, the support of stakeholders is necessary, which makes everyone dependent on other actors. Both private- and public sector organizations have to cope with networks as stated in the previous section about the explanation of SRM, which can be intra- or inter organizational. For example, companies in the private sector can take only the demands and wishes of their actual shareholders (stockholders) into account, while they do not look into the interest of the main stakeholders. These stakeholders are also part of the external multi-actor network and can have major impact on the decision making process.

Two types can be distinguished in governmental- or private organizations: hierarchical organizations and professional organizations. In the culture of a hierarchical organization the boss is the hero, while in a professional organization the professionals carry the organization (ten Heuvelhof & de Bruijn, 2012). Organizations of professionals are more and more becoming the standard because professionals overrule their managers on competencies and expertise (ten Heuvelhof & de Bruijn, 2012). When there is more expertise and competence needed from professionals, the organization becomes harder to manage from the top, which causes fragmentation. This change has consequences for decision making processes. Implementing things in a company were executed in project-based ways according the DAD (decide, announce, defend) principle, but are nowadays executed according a process through the DDD (dialogue, decide, deliver) principle (ten Heuvelhof & de Bruijn, 2012).

In processes negotiating and consulting between internal and external actors is the central viewpoint. Differences between a hierarchy and a network can be found in assumptions about their characteristics: ‘Uniformity’ in a hierarchy versus ‘variety’ in a network shows that more uniformity creates a greater span of control in an organizations. Also the ‘unilateral dependencies’ in a hierarchy versus the ‘mutual dependencies’ in a network shows the difference, because in a hierarchy the actors only have to obey one leader.
Furthermore the ‘openness’ to interventions of one actor in a hierarchy versus the ‘closedness’ to not accept hierarchical signals in a network is a huge difference. Lastly the ‘stability’ of a hierarchy versus the ‘dynamic’ character of a network clarifies the difficulty of exerting influence in a network by one actor. Although nowadays there are almost no pure hierarchical organizations, much organizations still have some of the characteristics to manage several processes (ten Heuvelhof & de Bruijn, 2012).

The characteristics ‘variety’, ‘closedness’ and ‘interdependence’ are seen as the structure of multi-actor networks. ‘Dynamic’ is a characteristic which stands alone and occurs throughout all other structures. Several opportunities and threats arise from the three first named characteristics, which are stated in Table 1. For example the character ‘variety’ has the opportunity that innovation is stimulated, but also the obstacle that intervention can be reinterpreted or transformed. The ‘dynamic’ character of networks entails recurring changes over time within the network (ten Heuvelhof & de Bruijn, 2012).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Obstacles</th>
<th>Opportunities</th>
</tr>
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<tbody>
<tr>
<td>Variety</td>
<td>Limited reach of intervention</td>
<td>Higher change of success with some of the parties</td>
</tr>
<tr>
<td></td>
<td>Possibilities for tailor made approach limited intervention reinterpreted/transformed</td>
<td>Possibilities for ‘divide and rule’</td>
</tr>
<tr>
<td></td>
<td>Intervention fails due to closedness and might become a ritual</td>
<td>Innovation</td>
</tr>
<tr>
<td></td>
<td>Leads to hit-and-run and so to chaos</td>
<td>Functional reinterpretation</td>
</tr>
<tr>
<td></td>
<td>Network as a whole becomes opaque</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leads to sluggishness</td>
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</tr>
<tr>
<td></td>
<td>Leads to poor decision making</td>
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</tr>
<tr>
<td>Closedness</td>
<td>Dependencies can be utilized</td>
<td></td>
</tr>
<tr>
<td>Interdependence</td>
<td>Incentive for cooperative behavior</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many exchange possibilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leads to rich and meaningful decision making</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Characteristics of the structure of multi-actor networks (ten Heuvelhof & de Bruijn, 2012), modified by (Heeringa, 2015)

Decision making processes are also different in networks compared to the hierarchical structure. In multi-actor networks several actors are responsible for the decision making. In networks the interdependency among actors is high, because decisions are unable to be made by independent actors. Decision making in networks can be seen as far more capricious compared to hierarchical structures. This can be divided in substantive- (the substance of problems and solutions changes often) and process based capriciousness (no clear start- or endpoint exists and it takes place in irregularly succeeding rounds). There are three types of power that actors can execute with decision making: production power (the power to execute something), blocking power (the power to stop something) and diffuse power (it is unclear to the initiator which power the actor has). As part of a multi-actor network it is important for an actor to maintain good relationships. Relation management can be executed in four types of relations: Functional- versus extra-functional relations and strong versus weak relations. Relationship management can strengthen the power position of an actor within a network if it is applied strategically (ten Heuvelhof & de Bruijn, 2012).

3.1.4 CURRENTLY USED APPROACHES TO EXECUTE SRM

Because of the young existence of SRM, the governmental- and private organizations gave their own twist to the execution of the discipline. As stated before, the activities of SRM are executed within Dutch LIPs for centuries, but a general approach or method for executing these activities is not yet implemented. The practical structure of SRM as stated in the previous section explains the structuring of SRM activities within working fields. This section will elaborate several currently used approaches or methods to execute SRM by governmental- and independent organizations. In the public sector the IPM-model of RWS (Rijkswaterstaat, 2012) is becoming the standard method to structure LIPs and is therefore chosen to be researched from the public side. The SOM approach by Wesselink (Wesselink, 2011) is currently the leading method to execute SRM in the private sector and is therefore chosen to be researched from the private side. Furthermore a stakeholder management model for ethical decision making by de Colle (de Colle, 2005) from outside the infrastructure sector (real estate sector) is researched to get an objective view on the different possibilities to approach SRM.
The IPM model
The executive organization for Dutch governmental infrastructure projects: RWS, has created a uniform standard to organize and control how LIPs should be realized: Integral Project Management (IPM). This is not a new project management method, but a model to structure the execution of projects. This model originated from seven sub-processes which hold all activities and products of a project: project management, project control, market, design-technique, conditioning, decision making and public participation and communication.

These processes led to the creation of the IPM-model, in which five task holders have a role to manage the seven processes. SRM is one of these five roles and is executed by a special assigned stakeholder relationship manager. The other four roles are: project manager, project control manager, technical manager and contract manager. In Figure 5 is visualized how these roles are related to each other and to external stakeholders. During the introduction of the IPM-model in 2006 it was intended to be used in the execution phase, but now the exploration and plan study phase are also working with the model (Rijkswaterstaat, 2012).

Figure 5: Integral Project Management (IPM) model (Rijkswaterstaat, 2012), modified by (Heeringa, 2015)

The five task holders together form the project team, but each task holder also has its own team. Three of the seven stated sub-processes are executed by the stakeholder relationship manager: conditioning, decision making and public participation/communication. The other four task holders all execute one of the four remaining sub-processes. The task division according the IPM-model is stated in Figure 6. It is notable that the stakeholder relationship manager is responsible for three sub-processes as shown in Figure 6, while the other task holders are all responsible for one sub-process. This shows the importance of SRM in current LIPs. The IPM-model is focused on controlling the risks which arise from the sub-processes.

The project manager is primary responsible for reaching the project goals in relation to budget and time. This person is responsible for the whole team and steers the other task holders. The project control manager is responsible for the arrangement of aspects like planning, budget, quality and risks through the whole width of the project. The technical manager has the task to control the content specific technical aspects of the project and communicate this with the contractor. The contract manager controls the whole process around the contract, from preparing the contract, to executing the contractual terms. The stakeholder relationship manager is responsible for creating support and communicate with stakeholders to implement the project within the public- and private demands and wishes (Rijkswaterstaat, 2012).
The SOM approach

The term SOM stands for the words: Strategisch OmgevingManagement, which means ‘strategic stakeholder relationship management’ in English. It is an approach developed by Marc Wesselink and the Mutual Gains Advice team of Twynstra Gudde, to solve issues of organizations with their surrounding stakeholders and work together with those stakeholders on a sustainable dialogue. Wesselink explains SRM as a combination of stakeholder management and issue management. Stakeholder management is traditionally executed to serve the interests of the organization by minimizing risks from stakeholders with different interests (Rijkswaterstaat, 2009). Issues are events or developments to which stakeholders can be against or in favor. Issue management searches new issues in the environment of a project and ensures which stakeholders have an interest in the found issue. With the SOM approach, first the issues are inventoried and after that the stakeholders are identified to ensure a more complete view (Wesselink, 2011).

The SOM approach is based on the Mutual Gains concept (Wesselink, 2011), which states the sincere interest in the interests of other organizations during the search for solutions which are assessed as positive and supported by both parties. This means that collaborating in finding a solution which is supported by both partners is more beneficial than looking for solutions separately. Stimulating joint research, being familiar with the other organization’s interests and focusing on sustainable relationships are example principles of the mutual gains concept. Project based working (Projectmatig Werken in Dutch) is seen as one of the cornerstones on which the SOM approach is based. This leads to practical standards to maximize the results like: stakeholder analyses, issues-stakeholder-matrices, interest analyses and step-based plans. “The essence of SOM is a pro-active intervention strategy, based on the sincere interest in the interests of other stakeholders” (Wesselink, 2011).

Figure 7 shows the SOM method broadly in a model. The orange outer circle states a step-based plan which is made with the Mutual Gains approach and is meant as a guideline. These steps lay within four quadrants which are stated within the rectangles. The pink inner circle states the process which the internal organization has to run through to embed SOM into the organization (Wesselink, 2011).

Actually most current approaches on SRM are step-based plans, which all have the general steps in common: Identification of issues and stakeholders, prioritization of issues and stakeholders, stakeholder mapping, stakeholder engagement and evaluation and adjustment (Bourne, 2010). This can be seen as the standard step-based plan for the current execution of SRM. Therefore, the case study research should address this step-based plan to understand the practicability in current LIPs.
A stakeholder management model for ethical decision making

The section for Ethics, Law and Economics of the university of Castellanza discusses the role of stakeholder management in improving decision making processes in ‘A stakeholder management model for ethical decision making’ (de Colle, 2005). The outcome of the research is a model, which should be used as a management tool and can be applied by managers to improve the quality of decision making. The tool helps to identify the important interests and concerns of stakeholders. The report states that this model is not the only right way to approach stakeholders, but the steps in the tool can be used as tools to address issues. Whether the steps are used in this order or another, depends on the specific situation with stakeholders in a project (de Colle, 2005). This model is an example of how stakeholder management is approached in another field than the infrastructure sector, namely in the field of economics. In this way the similarities or differences can be noticed and used to compare with the current models which are used in LIPs.

The model contains ten steps discussing key elements to develop a good stakeholder management approach. Figure 8 shows the model with the identified steps, which should be taken to identify interests of stakeholders and take them in consideration. The model distinguishes the following ten steps (de Colle, 2005):

- Identify and map all stakeholders: All possible stakeholders which could be directly and indirectly affected by the project should be identified first.
- Assess issues at stake: after that, the legitimate demands and claims of the identified stakeholder groups should be recognized.
- Identify corporate values and existing commitments: in this step the organization stakes their own position according the stakeholder claims and issues.
- Prioritize issues: this step must be executed with strategic stakeholder management. The most urgent issues can be prioritized with a sub-tool like a power/interest grid.

![SOM model](image_url)
- Review/develop policies: practical solutions or strategies to solve the addressed issues should be developed in this step. Different stakeholder groups may need a different matching solution strategy.
- Set objectives: to make the solutions more effective, objectives should be set to the identified stakeholder issues.
- Measure performance: during the project the organization should be able to monitor how well the stakeholder process is going, according the made objectives.
- Communicate and report: communicating with both internal- and external stakeholders about the implementation of the solutions is crucial to achieve the objectives.
- Review commitments and policies: the developed solutions or strategies should be reviewed in order to see if it is necessary to adjust them.
- Continuous engagement: the final step clarifies the need of constantly engaging stakeholders during the process, to evaluate if everything goes according the set objectives.

Figure 8: Model for stakeholder management in decision making processes (de Colle, 2005), modified by (Heeringa, 2015)

### 3.1.5 SHORT CONCLUSION ABOUT THE EXECUTION OF SRM

Concluding this literature study, it is clear that SRM is a relatively new discipline in the construction of LIPs. It has become one of the main disciplines within a short time, because it is inevitable that a LIP has impact on its surrounding stakeholders. This interaction with stakeholders cause conflicting interests which leads to issues (King, 2010). The fact that SRM is a new discipline makes that contractors are still exploring the field and the influencing factors complexity and integrated contracts are making SRM increasingly difficult to execute. A general practical explanation of SRM from several literature is: "The involvement of all relevant stakeholders in a project and alignment of contradicting or supporting demands and wishes to reach shared goals". The practical structure of SRM is divided in five working fields: stakeholder management, communication, participation, conditioning and traffic management (Rijkswaterstaat, 2009). The scientific structure of SRM is researched with process management in the field of stakeholder management. Several methods on the current execution of SRM have been created in different approaches. The IPM-model of RWS is used in the public sector as standard method to structure LIPs and the SOM approach of Wesselink is currently the most used method in the private sector to execute SRM. Another method to execute SRM in the field of economics is researched to look at similarities or differences. A general systematic step-based plan which they all hold is: Identification of issues and stakeholders, prioritization of issues and stakeholders, stakeholder mapping, stakeholder engagement and evaluation and adjustment (Bourne, 2010).
3.2 COMPLEXITY IN LIPS

This paragraph covers the literature study on the second component of this report: complexity. At first the issues according complexity in LIPs are repeated from the problem definition, in order to clarify again why this literature study has to be executed. After that, a section will be dedicated to explain what complexity in LIPs is and how it originated. Furthermore, a section will be dedicated to create a structure of complexity in LIPs with different literature resources. This structure is divided in a scientific- and practical structure, because these contain different types of complexity. In the end a conclusion will state the findings of this literature study.

3.2.1 THE IMPORTANCE OF RESEARCHING COMPLEXITY

The reason why complexity is researched is because although it has always been present in LIPs, the current developments have made LIPs much more complex, executed in increasingly complex environments (Verweij, 2015). Complexity increased also because integrated contracts lengthened the execution of LIPs, which causes more dynamics. The contractor has to respond to changing demands and wishes of the client and surrounding stakeholders during the whole project, while the contract is static (Hertogh & Westerveld, 2009). It is important to understand the complexity to manage a LIP, because it has been recognized as a major factor in issues with decision making and achieving goals. Most complex issues in a LIP occur because the responsible manager or stakeholder is not able to identify the occurred complexity (Dunovic, Radujkovic, & Skreb, 2014).

Hertogh and Westerveld describe in ‘Playing with complexity’ (Hertogh & Westerveld, 2009) why complexity really is a main issue during the implementation of a LIP. One of the main indicators that complexity is inevitable is that interviews with project managers who were responsible for the implementation of a LIP always recognize that they had to cope with complexity in practice. These interviews were part of six case studies about the following LIPs: Betuweroute, High Speed Link South, A73-South, Gotthard, Lötschberg and West Coast Mainline. Furthermore, there are many perceptions about what complexity in LIPs really entails, but all practitioners face the same issues according the phenomenon. Therefore, it can be said that complexity and managing complexity are main issues during the execution of a LIP (Hertogh & Westerveld, 2009). Verweij states the importance of complexity in the introduction of his PhD thesis ‘Once the shovel hits the ground’ (Verweij, 2015). In the year 2003 the Dutch government established a Temporary Committee of Infrastructure projects (TCI), to research how the governmental overview of LIPs in the Netherlands could be improved. In 2004 the committee published their report with the findings that the ongoing complexity in LIPs were related to the cost overruns: “[A]nother constant factor in large infrastructure projects is the great dynamics and complexity. Their course is persistently unlike planned, they are influenced by many unpredictable trends and events, and the processes within which they are developed are extremely complex. [...]. A symptom of this complexity is the systematic overrun of the budgets of infrastructure projects.” (Verweij, 2015, p. 19).

3.2.2 EXPLANATION OF COMPLEXITY

The word complexity is used very much by practitioners who are executing LIPs. Nevertheless, the definition of the term complexity as applied in LIPs is often experienced as hard to explain (Verweij, 2015). The term complex is defined by different literature as: “made up of many interconnecting parts” (Wood & Gidado, 2008, p. 6). Construction projects are also made up out of interconnecting parts, but the construction process is one of the most complex businesses to undertake and the previously described definition is not extensive enough. Therefore, a more extensive definition for project complexity combining different resources is: “the measure of the difficulty with a variety of interconnecting parts in terms of people, products and processes” (Heeringa, 2015). This scientific view can be divided in detailed- and dynamic complexity (Hertogh & Westerveld, 2009). Although project complexity has been defined in a scientific way, practitioners state that complexity in practice is different and harder to define. In the practical point of view, complexity is explained as: “A project has extremely diverse characteristics, technology (innovation), contractors, politicians and other stakeholders play a very important role. That makes every project unique.” (Hertogh & Westerveld, 2009, p. 136). Because the scientific- and practical structure of complexity are the most completely described by Hertogh and Westerveld (Hertogh & Westerveld, 2009), those two structures are used as the standard for the rest of this report. A more elaborated explanation about the formation of the scientific definition of complexity and the emergence of the practical- and scientific structure can be found in Appendix A: Additional elaboration on the literature.
### 3.2.3 SCIENTIFIC STRUCTURE OF COMPLEXITY

The scientific structure of complexity as stated by Hertogh and Westerveld is extracted by Senge in “The Fifth Discipline: The Art and Practice of the Learning Organization” (Senge, 1990), from common elements found in different literature about complexity. He divides complexity in two perspectives:

- **Detail complexity**
- **Dynamic complexity**

This distinction is made because both complexities are distinctive in theory, they are adequately distinctive in practice and the distinction makes a good starting point to link complexity with management strategies. Hertogh and Westerveld adopted this scientific structure and use it as well (Hertogh & Westerveld, 2009). An extensive elaboration of the complexity types is stated in Appendix A: Additional elaboration on the literature.

#### Detail complexity

Detail complexity can be referred to as a system with many elements which have a lot interrelations. In this research the systems are LIPs and the elements are stakeholders, civil works, environment and so on. More interrelations between the elements does not always mean a higher complexity. Sometimes it depends on the length, strength or nature of the interrelations between the elements in a system. Detail complexity can be divided in three sub-systems:

- Stakeholders
- Product (Infrastructure facility)
- Activities

#### Dynamic complexity

The execution of a LIP is a challenging activity, because they have to be implemented in dynamic socio-physical environments. Unforeseen events are a certainty which always have impact on the environments in which LIPs are executed. Management plans are made to cope with the dynamic context with the expectations of managers based on their daily activities. Nonetheless these systematic activities cannot prevent unforeseen activities to happen. If something is unforeseen or expected depends on the manager who has to deal with the event. Unforeseen events can be divided in two categories: the ones which arise from physical sources and the ones that arise from social sources. Unforeseen events from social sources are all unique and therefore all need specific managerial responses (Verweij, 2015). The following characteristics are linked to dynamic complexity:

- The potential to evolve over time: self organization and co-evolution
- Limited understanding and predictability

### 3.2.4 PRACTICAL STRUCTURE OF COMPLEXITY

The practical structure of complexity is based on the book ‘Playing with complexity’ (Hertogh & Westerveld, 2009), because these hold all schools of thought about project complexity. They researched detailed viewpoints of practitioners to verify the practical complexities. The findings from this research were clustered into six categories. Furthermore, the relationship between the six different types of complexity and the relative importance of each type was measured. The following six types of complexity are distinguished in the practical structure (Hertogh & Westerveld, 2009):

- Technical complexity
- Social complexity
- Financial complexity
- Legal complexity
- Organizational complexity
- Time complexity

These complexities will be elaborated in this section, supplemented with literature from the different schools of thought as researched in ‘Towards a new model of complexity’ (Dunovic, Radujkovic, & Skreb, 2014). The last part of this section will state the application of a tool to address complexity (HM Treasury, 2014). An extensive elaboration of the complexity types is stated in Appendix A: Additional elaboration on the literature.
Technical complexity
The technical complexity in a LIP can be best described according two main issues:

- Unproven technology
- Technical uncertainty

Unproven technology is the extent to which a technology is innovative. Specific dimensions of the technology determine the level of innovation, like: provability, robustness, coupling, divisibility and functionality (Hertogh & Westerveld, 2009). Technical uncertainty can be described as the difficult choice for a technology, which is heavily influenced by the particular conditions were it has to be implemented (Williams, 2002).

Social complexity
Discussions about interests and demands of stakeholders and dealing with them, is the most important issue according to complexity in LIPs. Everything comes down to the social elements of dealing with stakeholders, which is therefore more important than other complexities. All schools of thought hold this complexity type since the start of exploring project complexity (Dunovic, Radujkovic, & Skreb, 2014). The overall finding of social complexity according to Hertogh and Westerveld is: “Social complexity in LIPs originates from conflicts of interest between the involved stakeholders that lead to different perceptions (opinions) and attitudes, on issues that have a large impact on their business, life or environment” (Hertogh & Westerveld, 2009, p. 152). Social complexity in a LIP can be linked with three elements which often occur during the execution:

- Conflicts of interest
- Different meanings
- Perceptions and large impact

Financial complexity
The financial complexity of a LIP is related to the Net Present Value (NPV), cost calculations and the financing of the project. This type of complexity is added by Hertogh and Westerveld compared to the complexities found in the different schools of thought and became very important since the introduction of DBFM(O) contracts. Financial complexity is divided in five elements:

- Costs and benefits
- Perception of cost developments
- Different perceptions on definitions and agreements
- Strategic misinterpretation, optimistic biasing and pessimistic biasing
- ‘Cascade of distortion’

Legal complexity
The legal complexity in a LIP is based on the Dutch construction legislation and is also added by Hertogh and Westerveld compared to the complexities from the different school of thought. The Netherlands is a very densely populated country with many stakeholders. Therefore, a strict legislation by the government is necessary in order to keep control (Aedes, 2013). The following issues characterize legal complexity:

- Changing and conflicting laws
- Extensive legislation and rules
- People involved need space to operate

Organizational complexity
The project organization of a LIP has to deal with all mentioned complexities. It is necessary that the project organization of a LIP has variety and complexity as well, because that is the only way to deal with the complex challenges of the environment. Organizational complexity is not only used for the structuring of the internal project team, but most importantly to divide the responsibilities and positioning of the project team towards the client (Williams, 2002). There are four described issues that divide organizational complexity:

- Find and keep people motivated appropriate to the challenge
- A lot of decisions with no clear ‘best solution’
- Numerous interfacing processes within the project organization
- Numerous contracts with contractors, consultants and suppliers have to be arranged
Time complexity
Time complexity is related to the other five named complexities because it arises from them. The long term impact of a LIP on the environment is an important factor of time complexity. There are a large number of parallel processes, which is necessary, because otherwise the project would take hundreds of years. The planning of a LIP continuously has to be adapted to the current situation. There are two main issues showing time complexity in LIPs (Hertogh & Westerveld, 2009):
- Long time frames with ongoing developments
- No consecutive process of implementation

The relative importance of the six complexity types
According many managers who worked on a LIP, all six complexities are present during the project. The difference is that not every complexity occurs equally often and significant. Social complexity occurs most often in every project, while legal and time complexity occurs much less often (Hertogh & Westerveld, 2009). Technical-, organizational- and financial complexity are also important, but not as much as social complexity. This confirms the earlier statement that social complexity is the most dominant complexity in LIPs.

Technical-, organizational-, financial-, and legal complexity serve more as input for social complexity. Time complexity turns out to be an independent factor which shows the practical effects of change in a project. Not only the internal project organization recognizes social complexity as the most dominant complexity, but also for the external stakeholders social complexity is the most important during a LIP. The fact that social complexity and also organizational complexity are often seen as the most complex, is caused by their sensibility for change over time (Hertogh & Westerveld, 2009).

3.2.5 SHORT CONCLUSION ABOUT COMPLEXITY IN LIPS
Complexity has always been present in LIPs, but the current developments have made LIPs even more complex, executed in increasingly complex environments. The term complexity is used very much by practitioners in LIPs. Nevertheless, the definition of the word complexity as applied in LIPs is often experienced as hard to explain (Verweij, 2015). An extensive definition for project complexity combining different resources is: “the measure of the difficulty with a variety of interconnecting parts in terms of people, products and processes” (Heeringa, 2015). Although project complexity has been defined in a scientific way, practitioners state that complexity in practice is different and harder to define. In the practical point of view, complexity is explained as: “A project has extremely diverse characteristics, technology (innovation), contractors, politicians and other stakeholders play a very important role. That makes every project unique.” (Hertogh & Westerveld, 2009, p. 136).

The structure of complexity is researched by different schools of thought, through history in both science and practice (Dunovic, Radujkovic, & Skreb, 2014). The detail- and dynamic complexity in the scientific structure and the six types of complexity in the practical structure eventually emanated from the different schools of thought. Dynamic complexity matters most in the scientific structure and arises from the changing interests and preferences of stakeholders over time. Social complexity is the most important and dominant complexity in the practical structure of a LIP and arises from conflicts of interest between the involved stakeholders that lead to different perceptions (Hertogh & Westerveld, 2009). Nonetheless every project has its own characteristics because it is unique, which could mean that one of the less influential complexities may become the main challenge in a LIP. Therefore, all types of complexity should be managed with the new discipline SRM as the leading method to solve issues (Hertogh, 2008).
3.3 INTEGRATED CONTRACTS IN LIPs

This paragraph contains the literature study about the third component of this report: integrated contracts. At first the importance of why this research about integrated contracts has to be executed is repeated from the problem definition with some additions. After that a section will be dedicated to explain integrated contracts and show the context in which they are used: Public-Private Partnerships (PPPs). Furthermore, a section will state the structure and different types of integrated contracts. In the end a conclusion will state the findings of this literature study, which leads to a set of variables for the theoretical framework of the literature studies.

3.3.1 THE IMPORTANCE OF RESEARCHING INTEGRATED CONTRACTS

The introduction of integrated contracts in Dutch LIPs causes ongoing changes in the responsibility and risk division between the public client and the private contractor. Integrated contracts are introduced due to a revolution in the market approach by the government. This revolution ensures the shifting of responsibilities to the market, under the concept: ‘markt, tenzij’ (‘market, unless’). This means that private contractors are being challenged to create solutions with creative ideas for issues. RWS started this revolution in the infrastructure sector, but this means that contractors have to change their philosophies. The private market has to let go of their traditional role and has to interfere with many management processes (Nijpels, 2011). One of the new responsibilities for the contractor is executing SRM, which is a new discipline for both client and contractor (Visser, 2013). Integrated contracts furthermore entail that public- and private responsibilities are separated, dividing the tasks. This causes difficulties for contractors, who executes tasks for which clients are more competent (Rijkswaterstaat, 2015).

The intention of the government for implementing integrated contracts was that they should have added values and make the execution of a LIP more efficient. Better risk division, higher quality, collaboration and financing are all aspects which should have intended added values for both client and contractor. The current situation has shown however, that the underlying tensions of these intended added values overrule the intended added values of integrated contracts (Verhees et al., 2015). These six intended added values of integrated contracts with their underlying tensions are stated in the introduction (p. 19). The implementation of integrated contracts in the Dutch construction industry started only several decades ago. This short existence ensures that they are still in the development phase and not much information is available on the performance of these contracts (Verweij, 2015).

An additional difficulty, emanating from the characteristics of integrated contracts, is that the strict responsibility division does not lead to the intended collaboration. Coming forward as one organizations could have the added value that stakeholders accept issues from an organization which they have to deal with the whole time. In the current situation they have to deal with different people from different organizations which creates a mess. These tensions occur for example if permits have to be issued by external stakeholders to be able to continue the construction. External stakeholders does not feel obliged to distribute permits to a private contractor, which can cause project delays. Integrated contracts are not flexible when it states that the responsibility to request permits lays with the contractor, although for obtaining some permits the client is more competent. These tensions lead to cost overruns and delays, which eventually lead to accusations between client and contractor about who is to blame for the corresponding mistakes (Wassenaar, 2015).

In general, developments in the infrastructure sector, like decreasing governmental responsibilities and the wish to execute design- and build activities integrally, have put pressure on the search for new forms of collaboration. The building process becomes increasingly complex in technical, functional and economic ways and increasingly more organizations are participating in this process. It is therefore necessary that controllability remains present. The intention of the implementation of integrated contracts was to offer a solution for this controllability (CROW, 2015). An integrated collaboration concept was implemented during a testing period in complex and simple IT, infrastructure and utility building projects. This eventually led to contractual terms, which are written down in the Uniform Administrative Conditions for Integrated Contracts 2005 (UAV-GC 2005). The application of the UAV-GC 2005 allows organizations to come up with innovative solutions, which contributes to the governmental goal to move responsibilities (Projectburo B.V., 2015).
3.3.2 CONTEXT AND EXPLANATION OF INTEGRATED CONTRACTS

The terms integrated contract and Public-private partnership (PPP) are often interchanged, which makes it important to understand the difference. Therefore, an elaborated research about PPPs is given in Appendix A: Additional elaboration on the literature. The rest of this main report will focus on integrated contracts.

At first it is important to explain how construction projects were executed with traditional contracts. In a traditional building process, the building activities from design, to construction and maintenance were executed sequentially by different contractors. The governmental client chose one or multiple contractors for every building phase and offered separate contracts for every contractor. This fragmentation often leads to coordination problems and failure costs. The fact that every contractor is responsible for one phase makes that contractors only care for self-interest instead of mutual interest (Rijksgebouwendienst, 2009).

Therefore, integrated contracts are introduced to prevent the pitfalls of traditional contracts and improve the building processes. ‘Supply chain integration’ is the basic principle of integrated contracts. This integration creates synergy between the collaborating organizations, with the objective to create better joint final products for less costs. There are different ways to bundle the activities of the different sequential building phases. By combining different design, build, maintenance and facilitating services in one contract, collaboration between different disciplines is enforced. Integrated procurement also triggers contractors to come up with innovative solutions, because they have to construct or maintain their own invention. These aspects would not come forward in traditional processes, because there is no shared goal or a shared rate of return. Another advantage of integrated contracts is that the involved organizations come together in an early project stage, which stimulates integral solutions (Rijksgebouwendienst, 2009).

The governmental client remains the initiator and the contractor executes the project through design- and build activities. Integrated contracts are implemented in the Netherlands since several decades according the Uniform Administrative Conditions for Integrated Contracts 2005 (UAV-GC 2005). Partly under the pressure of the decreasing governmental responsibilities and the wish to execute building activities integrally, the infrastructure sector searched for new forms of collaboration. After an implementation- and testing period, the broad construction experiences were documented and evaluated. Several juridical optimizations and additions led to the UAV-GC 2005. These contractual terms make a distinction between four different roles: initiative, design, execution and maintenance. The finance component falls outside the UAV-GC 2005, because integrated contracts with this addition (DBFM(O) contracts) have been created afterwards (Projectburo B.V., 2015). The following definition for integrated contracts is extracted from the literature and is used as standard for the rest of the report: “In integrated contracts the tasks and responsibilities of several construction phases and activities are merged for one contractor” (Heeringa, 2015).

Figure 9 states different contract types from very traditional to very integrated contracts, with responsibilities (A, B, C, D and E) in different construction phases.

![Figure 9: Contracting construction phases to contractors in different integrated contracts (Conducto, 2015), modified by (Heeringa, 2015)]
3.3.3 STRUCTURE OF INTEGRATED CONTRACTS
In this section the different integrated contract types which are used in Dutch LIPs are stated shortly. A more extensive elaboration of the different contracts can be found in Appendix A: Additional elaboration on the literature. This is important for this research because every integrated contract type has a different responsibility division. The most important contract types are elaborated in a specific sequence: from the traditional ‘specifications’ (Bestek in Dutch) contracts to the highly integrated ‘general contracting’ contracts. Several variants between these extremes are also stated, obtained from different resources.

- **Traditional specification contracts (Bestek in Dutch).** These are contracts in which a public authority hires a private company to provide an execution task or a service for a certain time period (Asian Development Bank, 2007).

- **Rationalization and Automation in civil Works contracts (RAW in Dutch).** This contract type is more like a standard methodology to write down the demand specification for a project (Conducto, 2015).

- **Turnkey contracts.** In a turnkey contract the contractor is responsible for the design and execution of a project (Conducto, 2015).

- **Design & Construct contracts (D&C).** In D&C contracts one contractor is responsible for the general design, final design, preparation and execution of a project (Bouwlogie, 2015).

- **Design, Build and Maintenance contracts (DBM).** A maintenance component of a number of years will be added to the contractual agreements of the D&C contract (Bouwlogie, 2015).

- **Design, Build, Finance, Maintenance (Operate) contracts (DBFM(O)).** Next to the previously stated responsibilities for the contractor to design, construct and maintain a project, a finance- and even an operation component can be added (Rijksgebouwendienst, 2009).

- **Build-Operate-Transfer and similar contracts.** A private organization gets a contract for a certain period to develop, finance, manage and exploit a project (Asian Development Bank, 2007).

- **Alliance contracts.** In an alliance in the Netherlands the client and contractor act jointly during the design and execution phase. They come forward as one organization (Wassenaer, 2015).

- **General Contracting contracts (GC).** In this case the contractor takes over all tasks of the client, from coordination to plan studies and from design to execution, without responsibility sharing between client and contractor (Conducto, 2015).

3.3.4 RESPONSIBILITY DIVISION IN INTEGRATED CONTRACTS
The introduction of integrated contracts has caused a shift in the responsibility division between client and contractor, as stated in the core problem (2.1). The integration of building phases and accompanying activities in one contract has led to changes in the risk division between client and contractor. In traditional contracts many risks were carried by the client, while in integrated contracts the risks are assigned to the organization which is most competent to bear it. Shifting these risks to the private market brings extra costs for the contractor, who has to request more money to adopt these relatively new risks. An important aspect of integrated contracts is therefore allocating and dividing these risks (Rijksgebouwendienst, 2009). The more complex and comprehensive an integrated contract becomes, the more complicated is the preparation of the contract. For LIPs the client and contractor have to comply with the European procurement directives, which bring a lot detailed demands for both sides. Because of the short existence of integrated contracts, the preparation costs have a very high load on both sides. A lot effort is needed in the early project phases because more activities have to be specified compared to traditional contracts, which leads to high transaction costs (Rijksgebouwendienst, 2009).
According the UAV-GC 2005 the client in integrated contracts has a role in which he stays at a distance from the design and build activities of the contractor. Nevertheless, the client has a social responsibility in constructing LIPs. The demands which emanate from these systematics are elaborated in the process demands of the demand specification (Vraagspecificatie in Dutch). The client remains authorized at all times to test and accept this demand specification. To test if the contractor’s registrations are reliable the client uses: audits, system tests, process tests and product tests. System tests are the most important, to ensure the quality assurance system (kwaliteitssysteem in Dutch) of the contractor (Projectburo B.V., 2015).

The UAV-GC 2005 states the role of the contractor in integrated contracts is to be responsible for the design activities, execution methods and executing (and in some cases multiannual maintaining) the project until completion. Multiple documents must be created by the contractor, were the quality assurance system serves as a basis. This base is completed with a project management plan and according the complexity of the LIP several work packages are created. These work packages consist of small technical processes for activities. Systems Engineering (SE) is the working field in which the design activities are shaped (Projectburo B.V., 2015).

The responsibilities of the client and the contractor according the UAV-GC 2005 are summarized in a memo made by ProRail. It states the most important obligations of both client and contractor according the UAV-GC 2005 in the fields of contracts, permits, exemptions, safety, soil aspects and more (ProRail, 2015). According the contractual obligations, the client has to ensure that the contractor timely receives all available information which they have, as far as the information is necessary for the contractor to construct the project and multiannual maintenance according the contract. The client is responsible for the content of the information which it has made available. On the other hand has the contractor the obligation to notify the client if the demand specification, added annexes, basic agreements or information from the client contains such mistakes, that it is in conflict with the demands of reasonableness and fairness to not inform the client (ProRail, 2015). According the obligations for permits and exemptions, the client has to ensure that permits, exemptions, disposals or permissions are available for the contractor on the times stated in the demand specification. On the other hand, the contractor has the obligation to obtain the permits, exemptions, disposals and permissions as stated in the basic agreement, which are not part of the demand specification. For both types of permits and exemptions the client and contractor should contribute with the other partner to obtain the permits if this is necessary (ProRail, 2015). The obligations for safety and health systems are officially governed by the client and the contractor is obligated to obey these systems. In the obligations for soil aspects the contractor can only be responsible for the soil conditions which are influenced by the construction activities (ProRail, 2015).

These obligations lead to several discussions between client and contractor about what falls within the obligations and what not. For example, if the client notices a failure by testing the design of the contractor but he does not mention this, it is not possible to claim compensation from the contractor for the consequences. These difficulties lead to long claims and difficult situations between client and contractors, which has led to the hiring of legal staff on both sides to look into possible bottlenecks of integrated contracts (ProRail, 2015).

### 3.3.5 SHORT CONCLUSION ABOUT INTEGRATED CONTRACTS IN LIPS

Figure 10 clearly shows the difference between the responsibility division in traditional contracts compared to integrated contracts. The contractor is much earlier involved in project activities in integrated contracts, compared to the involvement in traditional contracts. This led to the discussions about responsibility division between clients and contractors, instead of having the intended added values of integrating project phases.

![Figure 10: Shifting of responsibilities in traditional- and integrated contracts (SBRCURnet, 2014), modified by (Heeringa, 2015)](image-url)
3.4 CONCLUSIONS AND THEORETICAL FRAMEWORK

This paragraph contains more elaborated conclusions retrieved from the three literature studies about SRM, complexity and integrated contracts. Furthermore the important issues occurring in the three components will be stated. The findings and issues together form the theoretical framework in written form. The last section of this paragraph consists of the visualization of the theoretical framework. The theoretical framework is very important for the rest of the research, because it formulates the core concepts about the three research components, from the view of the researcher. The theoretical framework consists of a model for executing SRM in the current situation and two sets of variables from complexity and integrated contracts which serve as input for that model. The total framework serves as a handgrip to compare the core concepts of the existing theory with the practical outcomes of the case study researches (Verschuren & Doorewaard, 2007).

3.4.1 CONCLUSIONS AND MODEL OF THE CURRENT EXECUTION OF SRM

Since several years the importance of SRM in LIPs is acknowledged by governmental- and private organizations, which have embedded it as a discipline in their project teams. With the current social developments and social media it is inevitable that the impacts of LIPs on their surroundings remain unnoticed. Interaction with involved surrounding stakeholders to manage conflicting interests makes SRM indispensable in constructing LIPs. There is no general term for SRM, although the Dutch construction industry uses the word omgevingsmanagement, but the activities can be summarized in the following definition from different resources: “The involvement of all relevant stakeholders in a project and alignment of contradicting or supporting demands and wishes to reach shared goals” (Heeringa, 2015).

The practical structure of SRM can be divided in five working fields: stakeholder management, communication, participation, conditioning and traffic management. Stakeholder management is the most important and largest working field, because all activities relate back to stakeholder management. Stakeholder management is also the field in which current researches are executed and can therefore be seen as the scientific structure (this field is generally called process management in scientific terms).

There are several organizations which developed approaches to execute SRM in current LIPs. These approaches are mainly focused on the practical activities of SRM and can be used as guidelines. None of the developed methods are used as the standard approach for the execution of SRM activities. Leading approaches are the IPM model of RWS and the SOM approach of Marc Wesselink. The general systematic structure which they have in common is a step-based plan as shown in Figure 11, which will also be used as the input from SRM for the theoretical model.

![How is SRM currently approached in LIPs?](image)

*Figure 11: Theoretical model for executing SRM, a general step-based plan from different approaches (Heeringa, 2015)*
3.4.2 CONCLUSIONS AND VARIABLES OF COMPLEXITY

Although complexity has always been present in LIPs, it becomes more and more important because of the current developments in LIPs which become even more complex in technical- social-, organizational and more ways. An extensive definition for project complexity combining different resources is: "the measure of the difficulty with a variety of interconnecting parts in terms of people, products and processes" (Heeringa, 2015). Although project complexity has been defined in a scientific way, practitioners state that complexity in practice is different and harder to define. In the practical point of view, complexity is explained as: “A project has extremely diverse characteristics, technology (innovation), contractors, politicians and other stakeholders play a very important role. That makes every project unique.” (Hertogh & Westerveld, 2009, p. 136). Since the late 1950’s different schools of thought elaborated concepts for project complexity. Over the years different aspects of complexity were added and in the latest research by Hertogh and Westerveld all complexity types are combined. The detail- and dynamic complexity in the scientific structure and the six types of complexity in the practical structure eventually emanated from the different schools of thought. Dynamic complexity matters most in the scientific structure and arises from the changing interests and preferences of stakeholders over time. Social complexity is the most important and dominant complexity in the practical structure of a LIP and arises from conflicts of interest between the involved stakeholders that lead to different perceptions (Hertogh & Westerveld, 2009). Nonetheless every project has its own characteristics because it is unique, which could mean that one of the less influential complexities may become the main challenge in a LIP. Therefore, all types of complexity should be managed. Therefore, the following complexity types are used as variables will be used for the theoretical framework:

- Social complexity
- Technical complexity
- Organizational complexity
- Legal complexity
- Financial complexity
- Time complexity
- Detail complexity
- Dynamic complexity

3.4.3 CONCLUSIONS AND VARIABLES OF INTEGRATED CONTRACTS

A new market approach by the government about contracting in LIPs led to the introduction of integrated contracts. This revolution under the concept ‘markt, tenzij’ had the consequence that the responsibility division between client and contractor changed and currently still changes. Many tasks and responsibilities are shifted to private contractors who have to execute new tasks including SRM, which in itself is a new discipline for all organizations. The intention of integrated contracts was that they should have added values in the efficiency of executing LIPs by integrating multiple building phases and activities in one contract. Furthermore a PPP (long term collaboration between the private market and a governmental client for the construction of a LIP) should have the benefit that the integration creates synergy in the collaboration, which leads to better final products for less costs. Nevertheless the current situation shows that underlying tensions instead of added values have the upper hand in risk division, quality, collaborating and financing aspects.

The more integrated a contract becomes, the more responsibilities are shifted to the contractor and the separation of responsibilities grows, while more collaboration was intended. In traditional specification contracts the contractor gets the responsibility for a short period to execute one building phase, but the client is responsible for the main tasks in the project. In very integrated contracts (were DBFM(O) is the leading contract type) the contractor is responsible for the whole lifecycle of a LIP which can reach up to 30 years. An alliance contract is an exception to this development, because in these contracts collaboration is the standard and everything is done together, but these contracts are not frequently used yet. The UAV-GC 2005 states the responsibility obligations for both client and contractor in the fields of contracts, permits, safety, soil aspects and more. These obligations lead to several discussions between client and contractor about what falls within the obligations and what not. Figure 10 shows in the short conclusion about integrated contracts the shifting of responsibilities from the client to the contractor in traditional- and integrated contracts. The following variables from integrated contracts will be used for the theoretical framework:
- Responsibility of the client: what falls within the obligations of the client and what not?
- Responsibility of the contractor: what falls within the obligations of the contractor and what not?
- Responsibility of both client and contractor
- Responsibility division from very traditional to very integrated contracts

3.4.4 VISUALIZATION OF THEORETICAL FRAMEWORK

The theoretical framework is a combination of the findings from the three research components in the literature study. The framework is visualized in Figure 12 and summarizes the most important findings in a structured way. This framework will be used as input for the case study research (4), in order to ask interview questions about the same topics as the literature study. In this way the theory can be compared with practice to develop the design criteria for the solution tool (5). The theoretical framework can be seen as the concluding findings of the literature study.

Figure 12: Theoretical framework, the concluding findings of the literature study (Heeringa, 2015)
4. CASE STUDY RESEARCH

This chapter elaborates the case study researches, which are used to research the execution of SRM in LIPs in practice. The first paragraph elaborates the used method and the reason to choose for a case study research in this research. Also the way in which the cases are selected and data is gathered will be explained. In the second until the seventh paragraph the results of the six case studies are elaborated. The last paragraph consists of a cross-case analysis, which compares the case study results and concludes the findings of the case study research. These findings generate the input for the solution tool in the next chapter.

4.1 CASE STUDY METHOD

This paragraph of the case study research will clarify the used method by consulting several literature about case study researches. The word case study research will be elaborated and the relevant value of case studies for this research will be highlighted. Furthermore, the selection of the cases is elaborated and the way in which data is collected and analyzed will be clarified. Also the number of interviewed people and their role in the LIP is stated. The last section of this paragraph visualizes the case study protocol to get a good overview.

4.1.1 THE TERM CASE STUDY RESEARCH

The term case study research is elaborated by several literature sources. Swanborn refers to a case study as: "A case study is defined as the study of a social phenomenon, (1) in one, or only a few, of its manifestations (2) in its natural surroundings (3) during a certain period (4) that focuses on detailed descriptions, interpretations and explanations that several categories of participants in the system attach to the social process (5) in which the researcher starts with a broad research question on an ongoing social process and uses available theories, but abstains from pre-fixed procedures of data collection and data analysis and always keeps an eye open to the new gathered data in order to adjust subsequent research steps (6) that exploits several sources of data (informants, documents, observatory notes) (7) in which sometimes the participants in the studied case are engaged in a process of confrontation with the explanations, views and behaviors of other participants and with the resulting preliminary results of the researcher” (Swanborn, 2010, p. 13).

A case can be seen as a specific instance or manifestation of the phenomenon which is studied. The actual research of studying cases can be based on one (single-case study) or multiple (multiple-case study) cases. The case study can involve one single actor, or multiple (often interacting) actors. Depending on the research level, three divisions can be made in case studies. The micro-level concentrates on studies where comparable data about for example illness or psychology is gathered. The meso-level case studies consider an emphasis on detailed information about social processes and phenomena. The macro-level case studies are used to investigate projects which are uncovering relationships between causes and effects (Swanborn, 2010).

Verschuren & Doorewaard define a case study as a research where the researcher tries to gain an in depth and integral insight in one or several time limited objects. Case studies have the following characteristics: a small number of research units, more in depth than width, a labor-intensive approach, small domains, selective or strategic case samples, an open observation on the location and qualitative data gathering. Two variants of case study researches can be used: the single-case study, where only one case is researched in depth with the accent on triangulation and the comparative-case study, where different cases are studied with comparisons. The last variant can be divided in the hierarchical- and sequential method (Verschuren & Doorewaard, 2007).

According to Yin (Yin, 2009, p. 3), there is a misunderstanding about case studies, they imply the use of collecting a particular data type. Case studies can be done using either qualitative or quantitative data. The data can for example be gathered through observations, fieldwork, literature records, interviews or a combination qualitative and quantitative methods. A case study research actually represents a research strategy, which is combined with another research strategy such as an experiment or simulation. The difference between the case study research and other research strategies is that it tries to study present phenomena in their real-life context. There are three types of case studies: exploratory, descriptive and explanatory. A case study narrative is created from the gathered data, which arises from qualitative and quantitative sources (Yin, 2009).
4.1.2 ADDED VALUE OF A CASE STUDY RESEARCH IN THIS THESIS

In case study researches, answering the research question must be the purpose and starting point. If the goal of the research is to gain information about how people decide and perceive things, in relation to their interaction during a certain period, a case study is the optimal research strategy. There are four quality criteria for getting results in social scientific research, which are applicable for case study research (Swanborn, 2010):

- **Construct validity** means that there should be no variation in the measurements for single case. If variation in measurement still occurs it is justified by the concept. Therefore, the case studies in this research all have the same scope and interview questions, as stated in Appendix D: Interview protocol.

- **Reliability** can mean that the measurements should be independent of the context, independent of the interviewed person and stable over time. A case study protocol can be used to make replication possible for future research. Therefore, a data collection protocol is stated in section 4.1.4 and visualized in Figure 13, to enhance the reliability of this research.

- **Causal validity** states that the relation between variables interpreted as causal, should be truly causal. To assure this validity, multiple ways of data collection are used in this research to look at the causes from different perspectives: a data analysis, interviews and a cross-case analysis.

- **External validity** states that the results of the research should not only be applicable in the field in which they are researched, but also in other settings. This is ensured by testing the solution tool in a workshop (Appendix G: Tool Workshop, nieuwe sluis Terneuzen) on another case, also outside the scope of this research.

There are three types of purposes to conduct a case study research according to Yin: an explanatory, an exploratory and a descriptive purpose. The exploratory purpose is used in this research to create a possibility to improve the current situation in executing SRM, in the form of a tool (Yin, 2009).

The characteristics of LIPs contain the fact that every project is unique, which makes it hard to collect numerical data about specific topics, because a phenomenon occurs differently in every case. Also the contract between the client and contractor depends on the context and can therefore not be separated from the environment. According to Yin, the most applicable research strategies are a survey or a case study, because the research question contains a present phenomenon where the behavior in a specific context cannot be controlled (Yin, 2009). According to Verschuren & Doorewaard, a case study research is used for studying a social phenomenon where the researcher acquires fundamental information and get full insight in multiple processes (Verschuren & Doorewaard, 2007). The factors which influence the project are linked and the change of one aspect can influence the whole project in case study researches (Swanborn, 2010). These characteristics correspond to the chosen case studies and research objective of this master thesis.

In order to get a good understanding about the current situation of the three research components it is necessary that the respondents can tell their stories. The best strategy to get the most information is to use open questions that are not prefixed, which let the interviewees give a better insight in their motivations and actions. In case of using a survey study the questions would be prefixed and therefore would not create in-depth answers to understand the complete situation.

4.1.3 CASE SELECTION

According to Swanborn, the case selection depends on the limitations of the researcher (Swanborn P. , 2013). The number of chosen case studies is based on the limited time available to research the cases and the boundaries of the project scope (2.3). If there was more time more cases could have been researched, but six case studies will give a pretty accurate image. Furthermore there are at least two respondents per case, which should increase the reliability of the results. To get information about SRM, complexity and integrated contracts, ongoing projects should be researched. The overarching organization of VolkerInfra: VolkerWessels, has several finished and ongoing projects in the different working fields of LIPs. It is easier to contact participants for the interviews from within the company, which creates a larger group of available interviewees in a short period. Furthermore, these participants have contacts with the client of the case study, which makes it possible to collect information from both sides. The project phases up to and including the building phase of the selected LIPs are good fields to research SRM. VolkerInfra has a lot experience with developments in SRM.
Choosing the cases properly is the most important criterion in achieving the largest understanding of a phenomenon. There are choices which must be taken according persons, places or events generally representing the larger phenomenon (Stake, 1994). For this master thesis the sector, project type, project phase, contract type and available interviewees are the criteria which are considered to be important for the case study selection. Multiple LIPs which are expected to qualify to become a case were researched on the five criteria. An extensive elaboration on how and why exactly the six cases are selected is stated in Appendix C: Case study selection. The following six LIPs in Table 2 are chosen to use as case study projects:

<table>
<thead>
<tr>
<th>Possible case study project</th>
<th>Sector</th>
<th>Project type</th>
<th>Project phase</th>
<th>Contract type</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiphol-Amsterdam-Elmelle (SAA-One)</td>
<td>Infra</td>
<td>Road/bridge</td>
<td>Build</td>
<td>DFM</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A9-Bachhoevedorp</td>
<td>Infra</td>
<td>Road/crossover</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A2 Maastrecht</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>D&amp;B</td>
<td>Ballest Nedam</td>
</tr>
<tr>
<td>Haak om Leeuwarden</td>
<td>Infra</td>
<td>Road/crossover</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A15 Maasvlakte-Vaamplein</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>DFM</td>
<td>Ballest Nedam</td>
</tr>
<tr>
<td>A4 Delft-Schiedam (AADS)</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Zuidasdok</td>
<td>Infra</td>
<td>Road/rail/tunnel</td>
<td>Design</td>
<td>D&amp;C</td>
<td>?</td>
</tr>
<tr>
<td>Galecooperbrug</td>
<td>Infra</td>
<td>Road/bridge</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Maximakanaal</td>
<td>Infra</td>
<td>Channel</td>
<td>Finished</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Oosterscheldekeren (OSK)</td>
<td>Infra</td>
<td>Road/Barrier</td>
<td>Build</td>
<td>Maintenance</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>DoorStreetStation Utrecht (DSSU)</td>
<td>Infra</td>
<td>Rail</td>
<td>Build</td>
<td>OPC</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Maasvlakte 2</td>
<td>Infra</td>
<td>Land reclamation</td>
<td>Maintenance</td>
<td>DCM</td>
<td>Boskalis/van Oord</td>
</tr>
<tr>
<td>Zoo Emmen (Wildlands)</td>
<td>RealEstate</td>
<td>Zoo</td>
<td>Build</td>
<td>E&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>International Criminal Court (ICC)</td>
<td>RealEstate</td>
<td>Building</td>
<td>Build</td>
<td>E&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>City Hall + Station Hall Delft</td>
<td>RealEstate</td>
<td>Building</td>
<td>Build</td>
<td>Traditional</td>
<td>BAM</td>
</tr>
<tr>
<td>Stroomersnelling</td>
<td>Energy</td>
<td>Building</td>
<td>Build</td>
<td>Traditional</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Cable connection Roggeplaat+HVS</td>
<td>Energy</td>
<td>Cable connection</td>
<td>Build</td>
<td>Traditional</td>
<td>VolkerWessels</td>
</tr>
</tbody>
</table>

Table 2: Selected case study projects, (Heeringa, 2015)

4.1.4 DATA COLLECTION PROTOCOL

A data collection protocol structures the way in which data is gathered and states the content of the data. The data collection about SRM, complexity and integrated contracts is structured in a specific order. The use of a case study protocol will increase the reliability of the research results.

At first, a short case description about every case will be made to get a brief introduction and overview of the selected LIP. This data will be the introduction of every case study report, with an image of the area, project size, project goal, project scope and more factual data. Also the expected situation about the SRM, complexity and integrated contracts will be sketched with information from literature. Secondly, two or more respondents per LIP are selected for an interview, with at least one respondent from the client and one from the contractor. All respondents were informed through e-mail with a topic list and the duration of the interview. More information about the complete interview protocol, including the questions and questioning strategy can be found in Appendix D: Interview protocol. Thirdly, the semi-structured interviews are conducted with the SRM managers of the selected projects. The interview starts with an introduction about the research and some administrative information. Thereafter the three topics will be addressed by means of three starting questions and approximately four sub-topics which could be addressed by the interviewer. In the end the closure of the interview gives the interviewee the opportunity to give information which the interviewer may have missed.
Out of the information gathered from the interviews and case descriptions the most important issues and findings from SRM, complexity and integrated contracts will be summed up. The interview reports can be found in Appendix E: interview reports (only in the confidential master thesis). The last part of the case study research consists of a cross-case analysis (4.8), which will be executed after the interviews (Yin, 2009). The cross-case analysis in this report is used to compare the different outcomes about the three research components in the cases. Because of the use of different research strategies and multiple interviews per case, (case description, semi-structured interview, cross-case analysis) a reliable case study report can be created. Together, this data will give a reliable image of SRM in practice, to compare with the literature study of this master thesis. This reduction in likelihood of misinterpretation by applying multiple methods is generally called ‘triangulation’ in qualitative case work (Stake, 1994).

4.1.5 DATA ANALYSIS

The reporting of the case study is often a long narrative without structure, which is hard to read and write. Therefore, Yin states five techniques to analyze data from case studies: pattern matching, explanation building, time-series analysis, logic models and cross-case synthesis. The case study research of this report uses two techniques: explanation building and cross-case synthesis. This is in line with the two purposes to conduct the case study researches, mentioned earlier (Yin, 2009). At first, explanation building will be used to analyze the data about the three research components in the case studies. It is a special form of pattern matching and especially relevant for this case study research. Building an explanation about the case begins with a statement about the topic (SRM: on complexity and integrated contracts in LIPs), which is an expectation of how the topic will be present in the case. After that interviews with both client and contractor will clarify how the topic is actually is present in the case. The findings from the case results are compared with the case description to check the validity (Yin, 2009). Secondly, the cross-case analysis will be used as data analyzing technique. The results from the explanation building are used as input for the cross-case analysis, which is more superficial with multiple case studies. The outcome of the cross-case analysis should form general data on the current issues about the execution of SRM in LIPs and opportunities to enhance the situation. The general data will be compared with the literature research, to compare practice with theory. This results in a list of the most important findings and issues encountered in theory and practice, which will form the design criteria for the solution tool. Figure 13 shows an overview of how the cases are analyzed in one structured image:
4.2 CASE 1: EXTENSION OF TWO HIGHWAYS, A1/A6 DIEMEN – ALMERE HAVENDREEF

In this paragraph the presence of the three research components in the first case study research is elaborated. Questions which emanated from the literature study about SRM, complexity and integrated contracts will be asked in two interviews with the contractor and one interview with the client of this LIP.

**CASE DESCRIPTION**

The first case project is the extension of the highways A1 and A6 along a length of 20 kilometers. It is the most extensive LIP which is currently executed in the Netherlands and therefore the largest case study in this research. The project is part of a program with several highway extensions from Schiphol to Almere, to improve the accessibility of the northern ‘Randstad’ (most crowded part of the Netherlands, including the four largest cities). There are two reasons for the execution of the program: the growing mobility in the northern ‘Randstad’ due to economic developments and the insufficient capacity of the current roads to accommodate this growth. The goals of the program are to create better accessibility, better traffic flow and to stimulate economic developments, employment and livability in the area (Rijkswaterstaat, 2015). Figure 14 shows the whole trajectory of this project and the most important surrounding cities.

The extension of the A1 and A6 includes the widening of the highways along the whole route and the construction of several new civil works like: bridges. The LIP contains many sub projects which could have been a LIP on their own, with the ‘Big five’ as leading challenges: a new bridge across the Amsterdam-Rijn channel, a new bridge replacing ‘Hollandse Brug’, an aqueduct in the Vecht across the A1, a new rail bridge near Diemen and a new rail bridge near Muiderberg (Bouwformatie, 2015). More examples of building activities are: the extension of the A1 from 2x3 to 2x5 lanes, the extension of the A6 from 2x4 to 2x5 lanes and an eco-passage near junction ‘Hoge Ring’. RWS is the public client who issued a DBFM contract to a contracting consortium, which was signed at December 2012 and will last up to 2040. The actual execution of the project started in 2014, because it was visible for the users and surrounding residents then. The building phase lasts up to 2020 if everything goes according the plan. Because of the large DBFM contract a special financing structure was needed. The contractor finances the design and build phase and the client pays money at sequential points in time during the maintenance phase, with one large amount of money at the completion date. The contracting consortium was selected by the RWS based on the Economically Most Advantageous Tender (EMAT), in which both price and quality are taking into account during the procurement.

**EXECUTION OF SRM**

It is expected that the execution of SRM has a very extensive role in this LIP, because the project covers a large area with a length of 20 kilometers with many surrounding stakeholders. Also the finance component of the DBFM contract is expected to give troubles for the execution of SRM, because of the tight deadline.
Respondent of the client
The way in which SRM is executed in this LIP corresponds with the standard way of executing it by RWS in the last years: through the IPM model and the SOM method, applied in the five working fields. The respondent of the client is satisfied with the execution of SRM: “In general this project elapses very well without major issues or delays in the field of SRM, although the finance component of the DBFM contract brings complications”. The finance component ensures that the deadline really has to be achieved or even brought forward, otherwise the client will not pay the large amount of money and the banks will ask high interests. This puts pressure on the SRM activities, because all activities need to be done in short time slots. Because of a large stretched area used for the project the many stakeholders are divided in two clusters, the A1- and A6 stakeholders.

First respondent of the contractor
SRM was not executed with a particular method by the contractor, like the client did. Nevertheless there was an SRM plan, based on experiences of the managers. The currently developed methods can be good handgrips, but the execution of SRM depends very much on the personal relationship between the SRM manager and the client and stakeholders. Most difficulties in the field of SRM occurred because the UVOs (execution agreements) which were signed between client and contractor, did not correspond with the agreements between the client and stakeholders. This led to conflicts between the contractor and stakeholders. The first respondent of the contractor admitted that participation would have helped: “Participation is a good initiative for the future, but in a DBFM contract it becomes difficult to execute because it has a narrow scope”.

Second respondent of the contractor
The second respondent of the contractor also admits that there was no standard method for the execution of SRM, but it was based on previous experiences. The second respondent indicated the same struggles in the execution of SRM according UVOs which were not communicated well: “There were UVOs which were not complete or not present in a demand specification, while they were arranged between RWS and a stakeholder in an earlier phase. Poor communication ensured that the UVO’s did not reach the contractor or were differently interpreted”. This led to inevitable changes in the contract, which were executed with a VTW (amendment request) by the contractor and after that a WOG (amendment by client) to execute the change. The current long processes for changes are outdated, because the changes could be tackled when the client collaborates with the contractor more early and add their technical expertise.

4.2.3 COMPLEXITY
The fact that this LIP contains sub project which could be a LIP on their own, suggests much technical complexity. Because of the large area use many stakeholders are involved, technical difficulties will rise and a large organization is needed to steer the project. These aspects will probably lead to social-, technical- and organizational complexity and also time complexity could cause issues because of the strict DBFM deadline.

Respondent of the client
Although the project was very large and contained many spectacular sub projects, the civil constructions were not very complex, because the building methods were pretty standard. The fact that so many civil works had to be executed at the same time in the surroundings of so many stakeholders made it complex. This asked for a very large project team who could manage these difficulties within the asked time. Therefore the respondent of the client thought that social- and organizational complexity were the most important in this LIP: “the amount of stakeholders with their demands and the organizational structure of the project organization are the most severe complexities of this LIP”. Also the financing deadline puts much extra pressure on the social- and organizational complexity, which makes time the third important complexity type.

First respondent of the contractor
This respondent named examples of complexity during the project, like: high traffic pressure, large areas, different stakeholders with changing interests, a lot civil works within the project and a large project team who had to reach a common goal. These examples can be traced back in several of the found complexities in the literature study, but social- and organizational complexity were seen as the most difficult. The respondent found much organizational complexity in the project team: “In a very short period the project team had to grow from 25 people to around 300 people, with all noses in the same direction”. 
Second respondent of the contractor
Dealing with the demands and wishes of different stakeholders and people within the organization, was the hardest task according this respondent: “Every single stakeholder thinks something about the project and searches all documents in detail to get the maximum out of it. Within the organization it is hard to steer people from another department, like he designers, while in a small project that would be easier”. These aspects can be traced back in social- and organizational complexity, which are also the complexity types named by the other respondents. All other complexity types were present in the project, but social- and organizational complexity were the hardest to manage. Dynamic complexity is also very important and can be found back throughout the project, because there were difficult changes which had a large impact.

4.2.4 INTEGRATED CONTRACTS
Because the project has a DBFM contract of 30 years, it is expected that the responsibility division is strictly divided and most of the responsibilities lay with the contractor. In the old responsibility division between client and contractor RWS made agreements with stakeholders and validated them with the contractor, but in the integrated contracts stakeholders and contractors have to validate the agreements themselves.

Respondent of the client
All different working fields of SRM had their own responsibility division between client and contractor. Although the DBFM contracts suggests that all responsibility for the total 30 years lay with the contractor, RWS had many supporting tasks with engaging stakeholders. A perfect contract without changes would be the solution for SRM, but this does not exist yet. Main difficulty in responsibility divisions according the respondent was the confusion about the UVOs: “There is a difference between what the stakeholders expected to get from RWS and what they really get from the contractor, because of a lack of communication (or deforming agreements because of wrong interpretations) between the client and contractor”. In addition, the finance component of the contract makes it harder to execute these changes, because the deadline has to be reached.

First respondent of the contractor
In general the responsibility of the client was to monitor the contractor through audits, while the responsibility of the contractor was to deliver the service. The responsibilities were clearly divided and stated in the contract on beforehand. The DBFM contract type did not stimulate collaboration to take on stakeholders together because everything was fixed. This could have been different in other contract forms like an alliance: “This is because the main goal of an alliance is collaboration and knowing each other’s interests. If a project is executed with this way of working, it does not matter which contract type is chosen”.

Second respondent of the contractor
According the first respondent of the contractor, the responsibility of the client was in general to facilitate (define agreements which are made in advance in UVOs) and the responsibility of the contractor was in general to construct. The main issues according the responsibility division is the understandability of the UVOs, because after two years of construction still not all UVOs are signed and not everything is clearly stated: “The exact details of demands and expectations are often not stated in the contract, which causes that things are differently interpreted by the contractor”. Collaborating on engaging these stakeholders together as client and contractor would help to clarify everybody’s interpretations and a good solution could be made.

4.2.5 CONCLUDING FINDINGS
In conclusion it can be said that the client executed SRM with several standard methods like the IPM and SOM method, but the contractor executed SRM based on personal experiences. Most difficulties in the field of SRM occurred because the UVOs (execution agreements) which were signed between client and contractor, did not correspond with the agreements between the client and stakeholders. This led to conflicts between the contractor and stakeholders. The social complexity of many different stakeholders and organizational complexity of the project organization were recognized by all respondents as most important. Furthermore the tight deadline which is caused by the finance component of the DBFM contract made changes even harder to deal with. The fact that the responsibility division is prefixed and strictly divided in the contract makes collaboration and flexibility almost impossible between client and contractor.
4.3 CASE 2: CONSTRUCTION OF THE A4 HIGHWAY, DELFT – SCHIEDAM

The second case study research consists of a case description and interviews, to research the SRM, complexity and integrated contracts in this LIP. Two interviews were conducted with one respondent of the client and one respondent of the contractor, to research the three components in practice.

Figure 15: Area overview of the new highway and the surrounding cities (Heeringa, 2015)

4.3.1 CASE DESCRIPTION

This case study investigates the construction of a new highway between the cities Delft and Schiedam, as part of the total A4 highway, with a total length of seven kilometers. The first plans for this missing piece of the A4 highway originated in the 1950s of the previous century. Due to much resistance from the surrounding environment the construction of the highway finally started many years later, in 2011 (Van Hattum en Blankevoort, 2015). The reason why the new highway had to be constructed is because the road capacity between two of the largest cities of the Netherlands, Rotterdam and the Hague, is not sufficient to take care of the traffic demand. The A13 is the only main highway connection between Rotterdam and the Hague in the current situation. This is causing long traffic jams every day, which lead to: poorer accessibility of surrounding villages, congestion after accidents, air pollution and nuisance (Rijkswaterstaat, 2015).

The new highway is part of the total area development program IODS (Integral Development between Delft and Schiedam), which embeds the highway in the landscape, together with recreation facilities and extra nature. A part of the highway at the side of Delft of 2.6 kilometers will be deepened half into the ground, another part of 1.4 kilometers in the middle of the open country will be deepened completely and the last part between the buildings of Schiedam will be executed as a land tunnel of 2 kilometers. After that the highway is connected to junction ‘Kethelplein’ in the beltway of Rotterdam. The total trajectory of the LIP is visualized in Figure 15. The highway consists of two driving lanes from Delft to Schiedam and three driving lanes from Schiedam to Delft. Furthermore noise absorbing walls in the deepened construction, 100 hectares new nature, walking trails, an eco-aqueduct of 40 meters wide and a rooftop park will be constructed. This total area development plan ensures that the highway is not visible and audible in the surrounding polder and nature is preserved. RWS is the client of this project and awarded the project to a contractor consortium, who had won the tender based on EMAT. The LIP is executed with a D&C contract which was signed in 2011 and will finish in December 2015, when the highway should be open for traffic (VolkerWessels, 2015).

4.3.2 EXECUTION OF SRM

Although the project is executed in an open country field it is still expected that stakeholder issues are very important in this LIP, because the opponents have delayed the construction of the highway for over 60 years.
The sensitivity of the project puts extra pressure on the client and contractor. Furthermore it is expected that ecological aspects are a big challenge in this project, because the flora and fauna plays an important role and should stay as unharmed as possible.

**Respondent of the client**

The way in which the client executed SRM was through several standard methods, which correspond to the current methods found in the literature study. The IPM model of RWS was used to structure the project management and the SOM method was used to execute SRM itself. The respondent of the client thought that not the model itself but the principle of the model was important in executing SRM: “In theory SOM is a methodology, but in practice we used it to carry out an attitude towards stakeholders. Honestly being interested in the interests of the stakeholders and embed their demands in solutions was the main intention”.

The importance of SRM in this project goes back to the 1950s, because since the beginning of the initiation of this LIP the surrounding environment effects the project. The trajectory of the highway goes through four different municipalities, with landscapes differing from urban cities to forests and agricultural land. Therefore it was important for the project organization to participate with the surrounding stakeholders. These stakeholders created demands and wishes for over 50 years, which were taken into account during the integration of the highway in the landscape. The respondent of the client thinks that participating with stakeholders and listening to them was important to come to a solution: “A main importance of SRM is building a relationship with your stakeholder. This is the core of SRM, otherwise the other activities will not be effective”.

**Respondent of the contractor**

The execution of SRM was mainly based on understanding the interests of the stakeholders and come to solutions with their demands and wishes taken into account. The used tool to accomplish this was the SOM method, which was an important component during the meetings. Of course there were some issues, mainly with the water management and foundation of the deepened highway, but through good collaboration with the client and participation with stakeholders good solutions were created. The respondent of the contractor experienced that collaboration through SOM and mutual gains was very important, but the lack of flexibility in the contracts made it hard to apply: “The principles of SOM and mutual gains about collaboration are very clear and important, but the current contractual boundaries obstruct to apply the methods in practice”. Participation with stakeholders had an important role in this LIP, because many stakeholders formed their opinions and ideas about the project during the long preparation phase. Several meetings were organized with representatives of surrounding stakeholders to involve them in the decision making to a certain extent.

**4.3.3 COMPLEXITY**

A highway which has to be hidden in the environment over a length of seven kilometers through different types of landscape is expected to hold many complexities. Furthermore the resistance of many stakeholders against the project for over 50 years suggests a high stakeholder complexity and much political sensitivity.

**Respondent of the client**

The new highway between Delft and Schiedam is technical unique project, because it is actually a chain of civil works connected to each other along seven kilometers. The half deepened- and completely deepened road are mainly executed below the groundwater level and the land tunnel holds very complicated technical installations. The fact that the new highway is mainly executed in an open country field without traffic and much population, suggests that the construction should be simple. Nevertheless the area is one of the scarce natural areas which are left in this densely populated part of the Netherlands, which has led to much resistance from surrounding stakeholders during the past 70 years. Eventually the government approved the construction in 2011, because the traffic intensity on the other roads was simply too high. Still the interests of surrounding stakeholders had to be taken into account, because the resistance did not stop after the project was allowed. Therefore close participation with surrounding stakeholders led to the integration of the highway in the environment and a total development plan for the area. The respondent of the client recognized social- and technical complexity as most important in this LIP: “Examples of complexity are the facts that at this moment, a few months before the deadline, the tunnel installations still have to be tested and there are still stakeholders who are resisting”. Other complexities, like requesting environmental permits, were also present during the execution, but did not have as much influence as social- and technical complexity.
Respondent of the contractor
There are several examples which made the project complex: the highway has a long trajectory through four different municipalities, the large difference between the types of stakeholders, constructing the highway below groundwater level, requesting environmental permits and the long history of the project causing politically sensitive topics. The contractor dealt with complexity in a very structured way: at first an issue was identified, after that a solution was searched for the issue and in the end the solution was evaluated with client and stakeholders. It is notable that the respondent of the contractor stated one definitely most important complexity: “The issues with stakeholders and therefore social complexity, is the most important complexity of this project. All other complexities were present in a lesser degree, there is no second most important complexity”. Every complexity can be traced back to social complexity according the literature study, which makes the thought that social complexity is the most important not very strange.

4.3.4 INTEGRATED CONTRACTS
The client of this LIP awarded a D&C integrated contract and therefore it is expected that the contractor has a lot freedom in the way it designs and constructs this project. It is also expected that the responsibilities between client and contractor are strictly divided, were most responsibilities are shifted to the contractor.

Respondent of the client
There was a clear division of responsibilities between client and contractor. For example the client was responsible for all public communication and the contractor was responsible for all building communication. Also the contractor was responsible for the requesting of all necessary permits to execute the project. Although there was a strict responsibility division, the client supported the contractor when it was impossible for them to solve the issue. The collaboration between client and contractor expired very well, both organizations were supporting each other when it was necessary, but discussions about responsibility remained. The advantage of the D&C contract was that the contractor had much freedom to design an innovative solution, but the disadvantage was the absence of a maintenance component to ensure that the contractor created the project with very high quality. Therefore the execution of the tunnel installations got a separate maintenance component in an alliance form. The respondent of the client is no supporter of higher degrees of collaboration in contract forms: “The problem with new contract types were everything is shared like an alliance, is that the client and contractor still have different interests, which will not lead to integrated solutions”.

Respondent of the contractor
In general the D&C contract contained a traditional responsibility division, were the responsibilities are strictly separated between client and contractor. Nonetheless the client and contractor agreed that in the field of SRM collaboration is necessary in several activities. In general the collaboration between client and contractor expired very well. For example, the contractor engaged most of the stakeholders, but when they could not solve a disagreement, the client supported and sometimes took over the conversations. An advantage of the D&C contract in this project was the design freedom for the contractor, but this freedom also brought issues because of misinterpretations of demands and wishes. The respondent of the contractor sees that increasingly more responsibilities are shifted to the private market over the past several years: “In general I think that the responsibility division is clearly shifted to the contractor over the past several years, especially in integrated contracts, with the A4 between Delft and Schiedam as an example”.

4.3.5 CONCLUDING FINDINGS
It can be concluded that SRM during the construction of the A4 highway between Delft and Schiedam is executed according the currently leading SRM methods. The IPM model of RWS structured the project management and the SOM method and mutual gains approach were used for the actual execution of SRM. The main issues in this project were caused by surrounding stakeholders who object to the project since the initiation in the 1950s. Taking the interests of surrounding stakeholders into account by integrating the highway in the environment was one of the main SRM challenges. Both respondents agreed that the social complexity of the surrounding stakeholder caused the most issues. The client also experienced that technical complexity of the tunnel installations caused many issues. Despite the strict responsibility division in the D&C contract, the client and contractor collaborated in the field of SRM and supported each other when necessary.
4.4 CASE 3: RENOVATION OF A BRIDGE, PART OF THE A12 AROUND UTRECHT

This paragraph will give an overview about how the three components of this research are applied in the third case. Two interviews with one respondent of the client and one respondent of the contractor elaborate how SRM is executed and what the influence of complexity and integrated contracts is in practice.

![Area overview of the LIP with surrounding bottlenecks](Heeringa, 2015)

### 4.4.1 CASE DESCRIPTION

This case project concerns the renovation of a bridge, which is part of the A12 highway, in the beltway around Utrecht. The bridge is located between the junctions ‘Oudenrijn’ and ‘Lunetten’, two very busy intersections in the Dutch road network. It is the second busiest bridge in the Netherlands, in terms of passing traffic every day. Furthermore the bridge spans the Amsterdam-Rijn channel, which is an important shipping route through the Netherlands. Figure 16 shows the location of the bridge in an overview of the area. The bridge consists of two steel cable-stayed bridges with five traffic lanes each, making a total of ten traffic lanes (VolkerInfra, 2015).

The reason why the bridge had to be renovated is because a steel layer shows fatigue symptoms. This is caused by the traffic load on the bridge which has grown faster than expected and has reached its maximum. The bridge is reinforced, with the placement of four steel pre-stressed beams as the biggest technical challenge. New concrete pillars with a new foundation were placed to carry the heavier bridge. The asphalt on the steel driving layer is replaced by high strength concrete. Furthermore the bridge is raised with 90 centimeters, to create more room for the shipping traffic. After the renovation the bridge can be used for another 30 years, contributing to the accessibility of Utrecht, Amsterdam, Rotterdam and Den Haag by land- and water routes. At this moment the project is almost ready for delivery and will be finished soon (VolkerWessels, 2015). RWS is the public client of the renovation project and performs it as part of a program with fourteen bridge renovation projects throughout the Netherlands. A D&C contract for this project was awarded in 2013 and lasts to the end of 2015, when the project is finished. The price, reduction of nuisance, reliable execution and collaboration with the client were important criteria for the contractor selection. This LIP actually has two clients, because RWS hired a private management contractor who made the design and acted as co-client of RWS. The contractor works in the same building as the client to enhance collaboration (Rijkswaterstaat, 2015).

### 4.4.2 EXECUTION OF SRM

It is expected that the execution of SRM in this project is very important, because there are many important stakeholders in this densely populated area. Furthermore the shipping- and road traffic has to continue during the execution, which requires tight planning schedules and difficult technical solutions to reduce nuisance as much as possible.
Respondent of the client

The way in which SRM is executed in this LIP according to the client corresponds in many ways with the identified step-based plan in the literature study. Creating support in the initiation phase and identifying the stakeholders in later phases are part of the explanation. The respondent is a supporter of the IPM model: “The IPM model of RWS was used as standard organization model, although it is more like a project steering model instead of an SRM model. It is a very good development that since the IPM model all disciplines are in the project steering team”. Also the standard ‘less nuisance approach’ which is created by RWS containing seven steps was used during the project. Next to these project steering approaches no standard models for executing SRM like SOM were used during the LIP. Furthermore, the five working fields of SRM can also be recognized in this LIP, each holding a lot of important stakeholders because it is situated in a densely populated area (road owners, three municipalities, shipping organizations, cable- and piping companies, neighboring construction projects and more). Participation with stakeholders was seen as necessary and very useful: “participation with stakeholders in this project was inevitable, because too many stakeholders had to use the bridge during the construction”. Although there are no standard models used in this LIP, the client motivates the importance of the intentions of the ‘mutual gains concept’: “The approach encourages more collaboration between client and contract and I can confirm from personal experiences that collaboration really helps in issue solving”.

Respondent of the contractor

The contractor also confirms that there was not standard method for executing SRM, but it was based on the principle of investing in relationships: “What we mainly did was investing in the relationships with the different stakeholders. Not per se in identifying their interests, but more on the actual social relationship”. According the contractor the close collaboration with the client in the field of SRM was very important for the success of executing SRM. Both SRM managers from client and contractor helped each other in engaging stakeholders and discussed everything in an open way: “Almost everything I did in the field of SRM was together with the SRM manager of RWS and this was very fruitful and paid off really well”. Of course there were some crucial moments which resulted in conflicts between client and contractor, but in general the collaboration was very good, because of the openness to each other. A crucial moment in the execution of SRM related to a nuisance issue during one night resulted in the creation of a crisis protocol, which should have been a standard in every project according the contractor. The contractor generally named the same important stakeholders as the client, although the management contractor was one more important stakeholder who they had to deal with. The contractor thinks that the current models like the IPM, SOM and mutual gains approaches are good guidelines for SRM which fit within the vision of the contractor. Nevertheless these theories are hard to execute in practice because of the introduction of integrated contracts: “The philosophy of these contracts stand perpendicular on the vision of the SRM models to have sincere interest in the interests of stakeholders”.

4.4.3 COMPLEXITY

It becomes clear from the area overview and case description that this LIP is executed in a very complex environment, because the bridge is an intersection of two main traffic routes through the Netherlands: the Amsterdam-Rijn channel and the A12 highway. It is therefore expected that complexity played a major role in the execution of the LIP. An innovative technical solution for the relatively unknown steel construction suggests technical complexity, partly because a special management contractor is hired with much technical knowledge about the design. The role of this management contractor as extra client next to RWS suggests several issues.

Respondent of the client

The renovation project seemed to have a simple problem: an existing bridge has to be reinforced because of a higher traffic intensity than expected. Nonetheless a difficult technical solution had to be invented, which in addition had to be executed while traffic still had pass over and under the bridge. Both the technical solution and the reduction of traffic nuisance were very dependent on each other. The client therefore experienced technical- and social complexity as most important in this LIP: “Although the organization had to cope with all kind of complexities, social complexity and technical complexity were the most important complexities which SRM had to cope with”. A combination of these complexities can be found in practice: “both interests of the road- and channel traffic were aligned with the interests of the project team to execute the placement of steel beams in special assigned periods”. Organizational complexity is also mentioned by the client as important, because of the presence of a management contractor, but not as most important.
Respondent of the contractor

Technical complexity is seen as most important in this LIP according the contractor: “the main complexity of this project was the technical aspect, with the main focus on the unfamiliarity with fatigue of steel in a bridge after 40 years”. Next to that organizational complexity is seen as most important, because of several issues with the management contractor, while the client felt that social complexity was more important. Although there were a lot stakeholders, many permits had to be requested and much traffic had to be managed, technical- and organizational complexity caused the main issues for the contractor in this LIP. In the beginning of the project it was difficult for the project organization to manage complexity, in which a trial and error methodology was leading. After a while the organizational complexity was obviated and most technical aspects were solved pretty well in the end because much knowledge was gained. The lack of room for flexibility was seen as a weakness of the static contract, which led to dynamic complexity: “during the execution this static contract always causes complexities in the field of budget and time because there is no room for negotiations”.

4.4.4 INTEGRATED CONTRACTS

The LIP is officially executed with a D&C contract, but it was actually more an E&C contract in practice, because the design was already made by the management contractor. The D&C contract contained strict responsibility divisions in the activities, for example: building- and public communications were separated. The motto of the contractor was: ‘no surprises, no changes’ when they won the tender. This contractor had the advantage that they had a good plan for reducing the nuisance, because traffic obstructions were inevitable.

Respondent of the client

RWS executed the SRM tasks during the initiation phase and when the contractor entered the project they took on most SRM tasks. Although the contract had strict boundaries for responsibility division, both SRM managers tried to add flexibility in the field of SRM. “Specific stakeholder bound issues were actually the responsibility of the contractor, but in this project RWS and the contractor engaged the stakeholders which they could take on the best”. For example: a neighboring building site should be engaged by the contractor, but at some points RWS had more influence and helped the contractor. Both SRM managers from client and contractor only focused on SRM issues and left contractual negotiations out of the solutions: “although the solutions were sometimes conflicting with the contract, this led to openness and flexibility of the contract in the field of SRM”. This way of working was agreed upon on beforehand, which had to do with respecting each other’s interests.

Respondent of the contractor

In this project the responsibilities were divided between three organizations: the client, contractor and management contractor. The intention at the start of the project in the field of SRM was focused on trust and willingness to collaborate. Nevertheless issues occurred in the collaboration: “After some months changes and issues in the project caused friction and distrust between both partners”. Because the good intentions both SRM managers could talk about the issues with each other in a normal way and this led to good solutions. Although the project had a D&C contract the design was elaborated so far that there was no freedom for the contractor to innovate or create flexibility. Current responsibility divisions are very static, ‘stick to the plan’: “the way in which procurement currently works in LIPs leads to static organizations which have strict boundaries and sharp bids. During the execution this static contract always causes complexities in the field of budget and time because there is no room for negotiations”.

4.4.5 CONCLUDING FINDINGS

In conclusion, the execution of SRM with the influences of complexity and integrated contracts had a very important role in this LIP. SRM was mainly executed based on previous experiences and common sense instead of an existing model. Nevertheless, there were some standardized patterns like the IPM model, relationship building with stakeholders and collaboration between client and contractor. Technical complexity was seen as important by both client and contractor. Next to that, the social complexity of many stakeholders was important according the client and organizational complexity was important according the contractor. The D&C integrated contract created a strict responsibility division between client and contractor. Nonetheless, both SRM managers created flexibility by abandoning the contract in the field of SRM sometimes, by finding a solution together which fitted the issue the most.
4.5 CASE 4: REDIRECTION OF A CHANNEL, EAST OF ‘S-HERTOGENBOSCH

The fifth paragraph of the case study research chapter will state the findings about the three research components in the fourth case study. The components are covered in two interviews with a respondent of the client and a respondent of the contractor, to find out how they appear in this LIP.

![Figure 17: Area overview of the LIP with important surroundings](image)

4.5.1 CASE DESCRIPTION

A new piece of channel is constructed as a bifurcation of the existing channel ‘Zuid-Willemsvaart’, with a length of nine kilometers. The bifurcation starts near a business park south of ‘s-Hertogenbosch and will flow through Rosmalen to the Maas river. The old channel is partly improved in order to cope with larger ships. Also two locks are placed to deal with the height difference between the Maas river and the current channel. Furthermore eight bridges are constructed where traffic can pass the new channel and ProRail extends the existing railway bridge in order to create more space for ships. Next to that four siphons and five pumping stations are placed along the new route. Figure 17 shows the path of the new channel with important landmarks in the surrounding area (KWS, 2015).

The reason why this LIP has to be executed is that after the construction of the new channel larger ships with three layers of containers can reach the container terminal in Veghel, which leads to less freight traffic and less traffic jams. Also the city of ‘s-Hertogenbosch will profit because the larger ships do not have to pass the city center. The new locks are able to let bigger and more ships pass through the channel which makes it sustainable for the environment (VolkerWessels, 2015). RWS is the client of the project and awarded a D&C contract to a contractor’s combination, based on EMAT criteria. One of the main requirements which were demanded was a good collaboration with the client. Although the LIP had a D&C contract, which means a clear responsibility division, collaboration was the key principle in this project. All information was for example transparent and traceable from the start. The new channel is constructed almost parallel to the A2 highway, which is located east of ‘s-Hertogenbosch. The extension of that highway was executed in 2013 by almost the same contractor’s combination as the one which is chosen for this LIP. Therefore the existing SRM plan can be used and expanded. The contract is executed between 2010 and 2014, which means that the project is finished and currently open for shipping traffic. (RegioenBedrijf, 2013).

4.5.2 EXECUTION OF SRM

The contractor just executed a project in the same area, which suggests that executing SRM in this project will be easier because the surroundings are well known. Furthermore it is expected that the focus in the field of SRM will be on the collaboration between client and contractor, because this was one of the EMAT criteria.
Respondent of the client

The IPM model of RWS was used as a leading structure for the project management of the whole LIP. For the actual execution of SRM no specific model was used, it was more based on previous experiences. As stated in the case description, the collaboration with the contractor was the main principle during the construction. The respondent of the client emphasizes that RWS felt the responsibility to help the contractor if it was needed: “Although there were a lot responsibilities given to the contractor, it would have been a waste to not use our expertise at some points. In some issues we had to participate with stakeholders to create a solution, mainly in the field of water management”. The SRM manager of the client and contractor were always acting together and shared all information, transparency and traceability were key words in the communication. The respondent of the client thinks that the execution of SRM should not be dependent on models, because everybody will stay in their own role and collaboration is not stimulated. An exception is the mutual gains approach of Twynstra Gudde, because in that method collaboration is the basic principle.

Respondent of the contractor

There was no standard method which was used to execute SRM, but the contractor mirrored the structure of RWS to create a comparable structure. The only difference between the SRM structure of the client and the contractor is that the contractor had a separate traffic management department. The execution of SRM was mainly based on previous experiences and common sense and proved to be successful. One of the main reasons why this project was very successful was because both partners were willing to go through fire and water for each other. The collaboration between client and contractor was such a good example for the other stakeholders that the water board also wanted to join the project team and work in the same building. There was a lot mutual trust and respect, which is important for collaboration and the key to project success according the respondent of the contractor: “I experienced in this project that collaboration really was the key to a good execution of SRM”. Also the participation with other stakeholders was very important and went very well. For example, the design of a lock was changed due to the concerns of a specialized stakeholder. The current methods in the field of executing SRM are not always applicable for integrated contracts, because the contracts are not flexible enough. In this project it was managed to combine an integrated contract with good collaboration, which shows that it is possible to build in flexibility between client and contractor.

4.5.3 COMPLEXITY

The previous section stated that the execution of SRM was very successful, which suggests that the social complexity of the stakeholders was easier compared to other projects. On the other hand is it likely that technical complexity is important in this project because of the difficult groundworks and many installations.

Respondent of the client

The channel had many complex characteristics: roads and waterways crossed each other, difficult installations like locks and pumping stations with the newest technologies had to be installed and several scope changes occurred. According the respondent of the client, technical complexity was the most important factor and next to that social complexity also had an important role: “Technical complexity on the other hand was very important in this project, because many new installations were constructed. Also social complexity was important in this project because although we executed good stakeholder management, there were a lot of them”. All other complexities were also present in the project, but they were less difficult to manage. For example 750 permits had to be requested during the project, which suggests a lot legal complexity, but it were all standard procedures although there were a lot of them. Like in every LIP scope changes are inevitable, which leads to dynamic complexity. During this project client and contractor handled complexity in the best possible way. The respondent of the client emphasizes that the collaboration model with the contractor and participation with stakeholders were the main reasons for that success.

Respondent of the contractor

At the start of the project several managers from both client and contractor walked around the construction site and observed that this project should not hold much complexity. This thought was created on purpose, to limit the complexity in the created solutions during the rest of the project. Nevertheless it is impossible to deny that the project contained complexities, because it separates the cities ‘s-Hertogenbosch and Rosmalen which required new road connections and integration in the environment.
The physical challenges of the LIP forced the contractor to use new technologies to construct two new locks and to place several siphons and pumping stations. Next to that the time pressure at the end of the construction phase requested several innovative solutions to deliver a successful LIP. Therefore the respondent of the contractor observed that technical complexity caused the main issues and in the end time complexity also became important: “The techniques to create a complete new channel in such a short time period was a big challenge. Social complexity was mainly overcome because of good communication and negotiation”. Other complexities like social- and legal complexity also occurred, only because they were present in a high quantity. Once again collaboration is named as the success factor, this time in mapping the complexities in advance.

4.5.4 INTEGRATED CONTRACTS

The responsibilities were clearly divided in this project, but through openness, respect, trust and working in one project team collaboration was created and both partners supported each other when it was needed. Therefore it is expected that collaboration was a key factor, because the project was very successful.

Respondent of the client
In the beginning of the project the responsibilities were strictly divided like in a regular D&C contract, but during the project more and more collaboration was added to the SRM part of the contract. This was a logical consequence of the feeling for responsibility on both sides, because both SRM managers suggested to take on extra tasks. According the client the successful collaboration emanated from the fact that both SRM partners honestly wanted to adopt more tasks than agreed upon in the contract: “It can be said that the responsibility division was separated in the contract, but we collaborated when the situation needed it. For example a risk management plan was made that stated which issues the contractor had to deal with, which issues the client had to deal with and which issues had to be engaged together”. Collaboration with the client was a EMAT criterion in the tender on purpose, because it was always the plan to work together. The project was executed with a D&C contract in theory, but the SRM part had more characteristics of an alliance- or ‘bouwteam’ contract. It is not certain that an alliance or ‘bouwteam’ contract type would have been better for this project, just the collaboration characteristics should be applied in the execution of SRM. Therefore the D&C contract with the collaboration aspects in the field of SRM was a very good contract for this LIP.

Respondent of the contractor
This project had a contract with different responsibility divisions in every working field of SRM. For example the communication was divided in public communication for the client and building communication for the contractor. At the start a gray area emanated in the responsibility division of communication, because it was not clear if something was part of the public communication, or part of the building communication. Therefore a so called ‘communication match’ was made, which was clearly stated the responsibilities of building communication and the responsibilities of public communication. The respondent of the contractor emphasizes that the responsibilities for SRM were divided by consultation instead of by the contract: “In this project all SRM related issues was solved in collaboration between both SRM managers. The project really benefitted from this approach because everything went well without delays and budget overruns”. The tendency in the current development with integrated contract is the fact that the client feels that everything is fixed and responsibilities lay with the contractor when a contract is signed. During this project that was not the case, because client and contractor kept collaborating during the whole project. The SRM part of this project looked very much like an alliance because the managers did everything together and there was a shared risk pile.

4.5.5 CONCLUDING FINDINGS

In conclusion it can be said that there was no standard method for the execution of SRM, although the contractor mirrored the management structure of the client to have corresponding functions. Although the responsibilities were at first strictly divided in the D&C contract, the client and contractor added collaboration in the field of SRM. This collaboration was the main focus in executing SRM, coping with complexities and dividing responsibilities. Both SRM managers did everything together and also adopted tasks from each other when they felt it was necessary. Therefore the project went very well, which made social complexity not the most important in this project. Both respondents recognized technical complexity as the most important. Both respondents agreed that collaboration in the field of SRM was the key factor in this successful project.
4.6 CASE 5: RENOVATION OF A RAILWAY STATION, UtrechT CENTRAL STATION

This paragraph will state the findings from the fifth case study research, in which the three research components appear. The way in which the three research components are present in this LIP is researched with a case description and one interview with a respondent from the contractor. This is the first case study which is not conducted for RWS as client. In this case ProRail is the client because it involves a railway project.

![Figure 18: Area overview of the LIP, executed in a crowded environment (Heeringa, 2015)](image)

4.6.1 CASE DESCRIPTION

This LIP concerns the renovation of the central railway station in Utrecht located in the city center, as shown in Figure 18. It is the busiest railway station in the Netherlands used by 285,000 travelers every day. It is expected that in ten years 360,000 travelers will use the railway station every day. This increase in train travelers in the Netherlands is the main reason for the execution of this LIP. Currently malfunctioning of chaotic technical facilities furthermore leads to extra delays. The ambition is to have a train connection every ten minutes on the busiest routes. These issues can be solved with this LIP by disentangling the current tangle of railway tracks at the central station of Utrecht and construct straight tracks free from each other. Clear corridors and fixed departure platforms will lead to less delays and more passing trains per day. Therefore the title of the project: ‘DoorStroomStation Utrecht’, can be translated to ‘Throughput station Utrecht’ (ProRail, 2015).

This LIP is part of a larger program initiated by the ministry of infrastructure and environment, which includes several railway projects throughout the country to increase the total railway capacity. The project is executed for ProRail, which is the public client. The client awarded a D&C contract to a contractor combination of two railway builders. The contract started in 2013 and the LIP has to be delivered in 2016, with some finishing activities in 2017. The LIP is seen as one of the most extensive and most complex railway projects ever and contains activities like: the construction and renewal of railway tracks, cables, lines, overhead lines, technical facilities and the extension of existing platforms. When the project is finished 150 trains can pass through the renovated station every hour, which means 50 trains more than the old situation. The contract was awarded based on Best Value Procurement (BVP), which means that the contractor had to come up with a tender of high quality for an acceptable price (VolkerWessels, 2015).

4.6.2 EXECUTION OF SRM

As stated in the case description this LIP is seen as one of the most extensive railway projects ever and it is executed in the city center of Utrecht. Therefore the execution of SRM is likely to be important in this project. Furthermore it is expected that the SRM tasks are differently structured compared to the previous case study projects, which were all road- and waterway projects executed for RWS.
Respondent of the contractor
The execution of SRM was a very important aspect in this project. The fact that the SRM manager was part of the core management team confirms that it was an important task with much responsibilities. A well-known standard method for the execution of SRM was not used, but with a less-nuisance model for the environment the contractor invented their own standard method. Although the rest of the contract had strictly separated responsibilities, the execution of SRM was based on previous experiences and collaboration. The respondent of the contractor emphasizes that this was devoted to the relationship between both SRM managers and not to the contract: “The collaboration was not intended at the start of the project but the SRM managers accidentally could get along with each other very well, which was beneficial for the project”. The most important stakeholders for the contractor were neighboring construction projects, neighborhood associations, the municipality of Utrecht and passenger organizations. Most issues in the execution of SRM occurred due to the adjustment of all interests of the stakeholders, like with finding a suitable construction window.

4.6.3 COMPLEXITY
The fact that the LIP is executed in the city center of Utrecht and is called one of the most complex railway projects ever, suggests a high level of social- and technical complexity. Furthermore this LIP is executed at the busiest train station of the Netherlands, where trains are passing continuously during the whole execution.

Respondent of the contractor
The complexity in this project is not the used technique or construction methods, unlike the expected analysis. The fact that these techniques had to be executed in such a crowed area made it complex nonetheless. Organizing these logistics and adjusting it with the interests of stakeholders caused the main issues. The respondent of the contractor names social complexity as very important because of the adjustment of all interests of the stakeholders, but names organizational complexity as most important: “Organizational complexity was definitely the most important, because the collaboration between client and contractor was messy and complex and differences between the internal contractor organizations led to discussions”. Next to that, time- and financial complexity were also important, because tensions emanated from the project planning and the largest contract sum for a railway project ever. Flexibility in the contractor could have been a solution.

4.6.4 INTEGRATED CONTRACTS
The contract type is an integrated UAV-GC, in which the client already made the design until a certain level and in which the client elaborates it further and executes it. This is expected to give tensions because the contractor does not have much freedom left do adjust the execution to their own design.

Respondent of the contractor
The integrated D&C contract in this project had a special character. The client chose an integrated contract, which suggests the freedom for the contractor to design and execute the project. Nevertheless there was almost no design freedom in this contract, because the client already made several designs over the past fourteen years. The respondent of the contractor felt that the responsibilities were not evenly divided, mainly because the client had too much advantages due to an earlier start: “I think that this project could better have been executed with a ‘bouwteam’ contract. In those projects the client and contractor start at the same time and share their ideas and interests the whole time”. Responsibilities can be shifted to the market to a certain height. Some risks are impossible to solve for the contractor which makes it unfair to let them deal with it.

4.6.5 CONCLUDING FINDINGS
In conclusion it can be said that the execution of SRM was mainly based on personal experiences and collaboration between both SRM managers. This was not intended by the contract from the start, but the SRM managers accidentally could get along with each other and collaboratively dealt with stakeholders very well. Organizational complexity due to the messy collaboration between client and contractor is seen as the most important complexity. After that social complexity was very important due to the adjustment of every stakeholder’s interests. Next to that, time- and financial complexity caused tensions in multiple fields. The integrated D&C contract should have much freedom for the contractor in the design and execution, but the client already elaborated the design very far which led to tensions.
4.7 CASE 6: CONSTRUCTION OF A ZOO, WILDLANDS ZOO EMMEN

This paragraph states the findings of the last case study research, which concerns a project that has more characteristics of a real-estate project than a LIP. The project is also the only case study with a non-governmental client. It is therefore interesting to compare the findings about the three research components in this project with the real LIPs and look at the differences. One respondent of the contractor and one respondent of the client (not the actual client) are interviewed to research the three components in practice.

CASE DESCRIPTION

This case study project concerns the construction of a new zoo in the city of Emmen, which is called: Wildlands adventure zoo. The construction of this new zoo is not a particular LIP conducted for a governmental authority, but it is not a real-estate project for the construction of a building either. Therefore this project is unique and asks for creative and innovative solutions from both client and contractor. The new zoo is part of a program of projects for the renovation of the city center, carried out by the municipality of Emmen. Next to the Wildlands adventure zoo important projects in the program are a new town hall square, a tunnel and parking garage beneath the square to create more quality on the surface and a new theater which also serves as the entrance of the new zoo. The main reasons for the construction of the new zoo are that the old zoo in the city center is outdated and has no space for expansions. Furthermore the old zoo made financial losses in the past several years which can be resolved with a new sustainably zoo, according the municipality (Gemeente Emmen, 2015).

The construction of the new zoo had a special character, because the contractor was asked to create an experience instead of a construction. After completion the visitors should be guided on an expedition through different animal worlds. Therefore the contractor used a lifelike model (scale 1:87) instead of a traditional construction drawing, from which the objects were exactly copied during the real construction. The unique building activities include a variety of tasks in the fields of architecture, landscape design, infrastructure, installations and facility services, which have to be integrated in one experience. The zoo also contains amusement rides and the largest greenhouse of Europe, next to the animal accommodations. Much attention is devoted to sustainability during the construction and also for the exploitation of the zoo. The client of this project officially is DPE (Animal Park Emmen), which is the organization that owns the old zoo, but the municipality of Emmen also has much influence on the project. The municipality is the governmental authority who supervises the project as part of their renovation program and they partially financed the project together with the province. A D&C contract was awarded to a contractor based on Best Value Procurement during the tender. The contract was signed in 2012, the building activities started in 2013 and the project will be delivered in phases during last months of 2015. After that the animals will be moved from the old zoo and the new zoo will open its doors in March 2016 (VolkerWessels, 2015). Figure 19 visualizes the location of this LIP.

Figure 19: Area overview of the new zoo integrated with the city center (Heeringa, 2015)
4.7.2 EXECUTION OF SRM

As stated before this project is not particularly seen as a LIP or real-estate project because it is unique. Therefore it is expected that SRM is executed in a different way compared to the other case studies which all were LIPs, conducted for a governmental authority. The project still fits within the scope of this research, because it has a D&C contract and has the same characteristics as a LIP.

Respondents of the client

Officially SRM on the client’s side was the responsibility of DPE, who are the actual client of this project. In practice the municipality of Emmen also plays a role in SRM at the side of the client, because the project is executed under their supervision and they partially financed it. Especially during the preparation phase the municipality had several SRM tasks, because the construction site for the new zoo had to be prepared. There was no special assigned SRM manager or a standard method for the execution of SRM, like with current LIPs. SRM tasks like construction logistics, requesting and delivering permits, stakeholder management and communication were divided among different managers. The respondents of the municipality emphasized that they had to deal with several stakeholders, although they were not the actual client: “It is important to mention that although we were not the client or contractor, all stakeholders came to us with their complaints. This was mainly because we were the governmental authority and the total program is our responsibility”. Basically the municipality itself was the most important stakeholder in this project, because they had to deliver permits, finance the project and were the point of contact for other stakeholders. During the preparation phase most important stakeholders were already dealt with in order to give DPE and the contractor a free area to build on.

Respondent of the contractor

The respondent of the contractor stated that he executed several SRM tasks in the role of permit manager and ecologist, but that there was no special assigned SRM manager. The different working fields of SRM were divided between managers of the client and contractor. For example all communication tasks were executed by the client and all conditioning tasks were the responsibility of the contractor. There was no standard method for the execution of SRM, but the activities were executed based on personal experiences. Nevertheless the contractor used standard software tools, like VICE for systems engineering, which supported SRM activities. The contractor did not have to manage very much stakeholders during the execution, because the project is constructed in an open area. The municipality of Emmen was the most important stakeholder to deal with for the contractor, due to the fact that this project is part of their program for the renovation of the city center. The respondent of the contractor stated that participation with the most important stakeholders was necessary: “Participation with surrounding residents and the municipality of Emmen was an important component in the execution of SRM”. A standard method with the support of software tools is seen as an improvement for the execution of SRM in the future by the respondent of the contractor.

4.7.3 COMPLEXITY

The fact that the respondents of the client were not respondents of the actual client, but respondents of the municipality, suggests a lot organizational complexity already. The actual client referred to the municipality for this research topic and the municipality at their turn thought that this research topic could best be adopted by the actual client. After some e-mails back and forth it was still unclear who could tell the most about this topic.

Respondents of the client

The complexities in this project did not occur in the stakeholder activities according the respondents of the client. Most stakeholders were engaged in the preparation phase and during the execution the construction site was a free area. Complexities arose from the fact that DPE did not exactly know what they wanted to build at the start. During the design of the model and execution on site their end goal became clear. This process brought many changes in the design and execution which caused several difficulties with the contractor. Furthermore the unique character of the project brought several difficulties. For example delivering an experience instead of a building and non-standard specifications for the animal accommodations were unique activities which are executed nowhere else. Dynamic changes were also present during the whole execution of the project. The client states the following complexities as most important: “The two most important complexities were organizational- and technical complexity because of the unique character of this project”. 

Respondent of the contractor
The construction of a new zoo has several complex characteristics. The integral approach of the project organization to let every aspect in the zoo interact with each other made the project complex. Furthermore the changes which occurred during the project and especially while the project was already in a far stadium, were difficult to manage. This was mainly because the preference of the client changed during the execution and we had to adapt many documents. The respondent of the contractor sees organizational complexity as most important in this project and next to that legal- and dynamic complexity were also important: “The most important complexity during this project was definitely the organizational complexity of the internal- and external companies and authorities. After that, legal complexity and dynamic complexity were the most important during this project”. In the future it should be possible to execute these kind of projects as one contractor, instead of many different organizations, to reduce the organizational complexity.

4.7.4 INTEGRATED CONTRACTS
Further elaborating on the organizational complexity as stated before, the responsibility division is expected to have a difficult structure as well. The fact that the D&C is based on a model and the experience of the visitors instead of pure demands and wishes of the client suggests many contractual difficulties. The unique character and contractual changes during the project are expected to give the most difficulties.

Respondents of the client
The actual responsibilities on the side of the client were placed with DPE, but the municipality also encountered several responsibilities. The D&C contract was made based on a model and focuses on the experience of the visitors. The contract had a ceiling price and contained pictures and impressions from the model next to demands and wishes. The contractor had the responsibility to design and construct the project, were the accommodations of the animals had to meet special safety requirements. DPE had the responsibility to facilitate the project and deal with the surrounding environment. The municipality had the responsibility to monitor the project and was the governmental authority to provide permits. The responsibility division between the contractor, client and municipality was unclear at some points and knew gray areas. According the client collaboration is important in these projects, but the interests can overlap so much that personal roles are forgotten: “We think that good collaboration between a manager of the client and a manager of the contractor depends very much on the coincidence if they can get along, not on the contractual agreements”.

Respondent of the contractor
The contract of this project is a D&C contract, where the client clearly stated one ceiling price for the contract sum. Also a small maintenance component was added for the maintenance of the pathways in the park. Within this ceiling price the contractor had the freedom to implement changes or optimizations in the design and execution. Therefore the construction was connected seamless to the design. Several contractual changes due to the changed preferences of the client occurred during the project. These changes had to be executed within the ceiling price, which was a big challenge. The contractor felt that the collaboration between the client, contractor and the municipality worked well. The respondent of the contractor thinks that the right responsibilities were shifted to the contractor in this project, but that shifting too much responsibilities to the contractor can bring issues: “A disadvantage of the D&C contract could be that too much risks are shifted to the contractor, while the contractor is not competent to deal with the risks”. More collaboration in this project was not necessary because the current approach worked pretty well.

4.7.5 CONCLUDING FINDINGS
The construction of the new zoo near the city center of Emmen is a very unique project, which cannot be compared with other LIPs or real estate projects. SRM activities in this project were not executed according a standard method or by assigned SRM managers. The tasks were divided among different managers from the client, contractor and the municipality. This unique character led to several difficulties in terms of changes and the internal organization, because this is a one of a kind project. Therefore the organizational complexity of the internal and external organization structure and the dynamic complexity of the changes were the most important in this project. The D&C contract was based on a model and the experience for the visitors, executed within a fixed ceiling price. Difficulties arose because of contractual changes during the project.
4.8 CROSS-CASE ANALYSIS

In this paragraph the six individual case studies will be compared with each other. Several findings about the three research components SRM, complexity and integrated contracts came out of the case study researches. This paragraph consists of three sections corresponding with the three research components. Every section first states the similarities which are found between the cases and after that the differences between the cases are stated. These similarities and differences will be reviewed with the findings from the literature study (3). The end of every section contains the concluding findings about every research component. These findings will be used for the solution tool (5), together with the theoretical framework from the literature study, to support the execution of SRM. Appendix F: Cross-case analysis, consists of three extensive tables in which all comparisons between the cases are stated.

4.8.1 CROSS-CASE COMPARISON IN THE FIELD OF SRM

This section will further elaborate the similarities and differences between the six case studies in the field of SRM, which is the first research component. Out of the data analyses and interviews in the case studies six comparisons are distinguished, which are extensively elaborated in Table 9 in Appendix F: Cross-case analysis. In this table elaborations of every comparison in every case are stated. Table 3 in this section is a compact version of the extensive appendix to summarize the comparisons. These comparisons can be traced back in the interview questions about the execution of SRM. The similarities and differences in the case studies will be compared with the literature study (3) about SRM, in a literature review at the end of this section.

Similarities

The similarities are based on the six comparisons which are stated in Table 9 in Appendix F: Cross-case analysis and are summarized in Table 3. The following similarities in the field of SRM between the case studies can be distinguished:

- In four out of six projects standard methods to structure or execute SRM were used by the client. In these four projects RWS was the client. The contractors of all projects performed SRM mainly based on personal experiences, but sometimes tools were used to standardize some SRM tasks.
- In all six case studies collaboration was present between client and contractor. Most respondents felt that the collaboration between both SRM managers went pretty well. Of course there were issues sometimes, but through discussions and information sharing these issues could mostly be solved.
- Crucial moments or significant issues regarding SRM occurred in five out of six projects. All issues were stakeholder related and mainly concerned adjusting different interests or misinterpretations. In one project the client and contractor did not have issues with SRM, due to good stakeholder management.
- In five out of six projects the client and contractor participated with stakeholders in finding solutions. All respondents of these LIPs thought that participation was actually inevitable to create the LIP. Only in the DBFM project participation was not used, due to the ‘stick to the plan’ approach.
- In four out of six projects changes in the execution of SRM occurred. These changes all emanated from the changed preferences of the client, which resulted in adjustments by the contractor. In the other two projects there were no changes in SRM because of early involvement and information sharing.
- All twelve respondents of the six case study projects think that current methods for the execution of SRM are good guidelines or handgrips, but integrated contracts make it hard to apply them in practice due to the fact that flexibility and a less strict responsibility division is needed to use the methods.

Differences

The differences are also based on the six comparisons, which are stated in Table 9 in Appendix F: Cross-case analysis and summarized in Table 3. The following differences about SRM between the cases are distinguished:

- There was a large difference in the used methods for the execution of SRM. On the side of the client this difference was not that big, because RWS standardized some procedures with their IPM model. Nonetheless on the side of the contractor sometimes specific tools, or no methods at all, were used.
- There was a difference in the approach of collaboration between the projects. In three case projects collaboration between both SRM managers was seen as the key success factor. The clients and contractors of these projects collaborated a lot, outside the contractual boundaries. In the other three projects it was chosen to collaborate as little as possible, to respect the responsibilities in the contract.
A difference between crucial issues of the case projects is that in three projects adjusting stakeholder changes gave most issues and in two projects adjusting the client’s preferences gave most issues.

The difference between the cases in participating with stakeholders mainly concerns the project phase in which this occurred. Participation was used in three cases during the design phase, to implement the interests of stakeholders in the design. Participation was used in two cases during the execution phase, because stakeholders had to use the existing infrastructure during the execution phase.

The differences in the occurred changes during the project are visible in the length of the change procedures. In two cases the changes had very long procedures which caused extra pressure on the deadline. In two other cases the changes had short procedures to be implemented. In the cases with short change procedures the collaboration between client and contractor was very high.

Although all twelve respondents thought that the current methods are good guidelines and a standard for the execution of SRM would be good, they do not think that the current methods are perfect standards. New standards or methods should be more practical.

<table>
<thead>
<tr>
<th>Comparison SRM</th>
<th>Case 1: Extend A1/A6</th>
<th>Case 2: Construct A4</th>
<th>Case 3: Renovate bridge</th>
<th>Case 4: Redirect railway station</th>
<th>Case 5: Construct a new zoo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard method to execute SRM</strong></td>
<td>Client’s side, yes, IPM and SOM, Contractor’s side: no, personal experience</td>
<td>Client’s side, yes, IPM and SOM, Contractor’s side: yes, SOM, but more about the principle</td>
<td>Client’s side: only IPM for structure. No standard method on both sides for execution</td>
<td>Client’s side: only IPM for structure. No standard method on both sides for execution</td>
<td>Client’s side: no, Contractor’s side: no</td>
</tr>
<tr>
<td><strong>Client and contractor collaborate in SRM</strong></td>
<td>Sparsely, stakeholders were divided, just like the contract</td>
<td>No, but client and contractor supported each other when necessary</td>
<td>Both SRM managers of client and contractor collaborated a lot</td>
<td>Collaboration between the SRM managers is seen as the key factor for success</td>
<td>Both SRM managers of client and contractor collaborated a lot</td>
</tr>
<tr>
<td><strong>Crucial moments/ issues regarding SRM</strong></td>
<td>Most issues occurred with the misinterpretation of UVOs (execution agreements)</td>
<td>The main issues occurred due to the many different stakeholders. Several issues occurred, but openness between SRM managers always solved it</td>
<td>No significant issues regarding SRM, it was a very successful project</td>
<td>Most issues occurred due to the adjustment of all the stakeholders’ interests</td>
<td>There were no significant issues during the project, because the area was cleared</td>
</tr>
<tr>
<td><strong>Participation with stakeholders</strong></td>
<td>There was not much room for participation with stakeholders in this contract</td>
<td>Participation was an important aspect in this LIP</td>
<td>Participation has proven to be a very important factor in this project</td>
<td>Participation with stakeholders during this project was inevitable</td>
<td>Participation was very important, because the main stakeholder was also partly client</td>
</tr>
<tr>
<td><strong>Changing issues/ interests</strong></td>
<td>Long change processes had to be executed due to misinterpretation of agreements</td>
<td>Several important stakeholders changed their interests in favour of the project</td>
<td>There were no significant changes in the execution of SRM</td>
<td>The respondents did not mention significant changes in the execution of SRM</td>
<td>Many changes occurred due to the changing interests of the client</td>
</tr>
<tr>
<td><strong>View on currently developed methods</strong></td>
<td>They are good hand tools, but SRM depends much on the personal</td>
<td>They are clear and important, but lack of flexibility in contracts obstruct good application</td>
<td>They are a good guideline, but lack of flexibility in contracts obstruct good application</td>
<td>They are a good guideline, but lack of flexibility in contracts obstruct good application</td>
<td>It would be good in general to create a certain standard structure for the execution of SRM</td>
</tr>
</tbody>
</table>

Table 3: Cross-case comparison SRM, summary (Heeringa, 2015)

**Literature review**

In the literature study several standard approaches to structure or execute SRM are elaborated. Firstly, the importance of SRM was acknowledged in all case studies by all clients and contractors. In the current society it is impossible to implement a LIP, without involving surrounding stakeholders and taking their conflicting interests into account (KING, 2010). Next to that, all the investigated working fields of SRM as stated in the literature could be traced back in all case studies (Stakeholder management, communication, participation, conditioning and traffic management (Rijkswaterstaat, 2009)). An exception is the construction of a new zoo, because this was the only case without SRM as a discipline, but the SRM tasks were distributed among other managers. Furthermore, the leading model to structure SRM (IPM model of RWS (Rijkswaterstaat, 2012)) and the leading model to execute SRM (SOM approach of Wesselink (Wesselink, 2011)) as elaborated in the literature, can be traced back in the cases.
In all cases with RWS as client (extend A1/A6, construct A4, renovate bridge and redirect channel) the IPM model was used to structure SRM and in two cases the SOM approach was used to execute SRM by the client (extend A1/A6 and construct A4). In all cases contractors executed SRM based on personal experiences, which shows that the methods are not the standard yet.

Collaboration with the client is seen as a very important task within SRM in the case studies. In the three cases where collaboration with the client was high (renovate bridge, redirect channel and renovate railway station), it was recognized as the key factor for success in SRM. In two other cases (extend A1/A6 and construct A4) especially the respondents of the contractor admitted that more collaboration would have been better for the project. The fact that stakeholders not always accept the authority of contractors and want to talk to the client makes collaborating and engaging stakeholders together inevitable. In the literature about SRM not much could be found about collaboration with the client. Collaboration between client and contractor can be seen as a missing link in the current literature, because it was recognized as a key factor for success in three case studies. Also participating with stakeholders was an important task for SRM in the case studies. In five out of six cases (every case except: extend A1/A6) the SRM managers had to participate with stakeholders in order to construct the LIP. Participation has not been recognized as a working field by all resources in the literature. RWS recognizes it as a working field because participation with stakeholders is inevitable very often in LIPs (Rijkswaterstaat, 2009). Therefore participation in SRM should be researched in future literature.

All crucial moments or issues in the execution of SRM occurred in the field of stakeholder management. Main difficulties were contractual changes during the LIP and misinterpretation of agreements between client, contractor and stakeholders. The changes in the case studies emanated from changed preferences of the client, which caused long procedures. Misinterpretation occurred when the client made agreements with stakeholders in the preparation phase, which were not communicated well to the contractor. During the execution in the case studies the contractors constructed the LIP according the contract, while several stakeholders had agreed something else with the client. These changes and misinterpretation are elaborated in the literature, mainly in the resources about stakeholder management (ten Heuvelhof & de Bruijn, 2012).

**Concluding findings**

Important issues in executing SRM were found in the case study researches, which have been compared with the literature study (3). The following findings are seen as the conclusion of the cross-case analysis about SRM:

At first it is important to notice that a standard method for the structuring or execution of SRM has not yet been implemented in LIPs. Although several methods like SOM are currently developed to support the execution of SRM, they are sparsely used as main guideline. Only RWS has a standard model which they always use during LIPs to structure the project management. On the side of the contractor SRM is executed based on personal experiences and sometimes software tools make it easier. Nevertheless, all respondents from both client and contractor agreed that a standard method or model to execute SRM would be beneficial for the LIP.

Secondly it should be noticed that collaboration between client and contractor plays an important role during the execution of SRM, but nothing has been written about it in theory. In the cases where both SRM managers of the client and the contractor collaborated intensively, the execution of SRM in the LIP went very well. Nothing is written about collaboration in current theories about SRM, while it is recognized by the respondents who applied it as the key factor for a successful LIP. In the current situation the way in which client and contractor collaborate is dependent on whether they can get along with each other and personal initiative. Lastly the participation with surrounding stakeholders can be seen as a field which is underdeveloped. The fact that participation with surrounding stakeholders was inevitable in five out of six case studies proves that it is very important. Although some literature resources state participation as a working field in SRM, not much is written about how it should be executed. The fact that the influence of surrounding stakeholders is increasing in the current society makes it necessary to develop a standard on when to participate with stakeholders.

These findings are used for the design criteria of the solution tool and are summarized as follows:

- A standard method for the execution of SRM would be beneficial for a LIP.
- Collaboration between the client and the contractor should be normal instead of being a coincidence.
- Participation with surrounding stakeholders is inevitable in most LIPs and should be standardized.
4.8.2 CROSS-CASE COMPARISON IN THE FIELD OF COMPLEXITY

The similarities and differences between the six case studies in the field of complexity will be elaborated in this section. The seven complexities as found in the literature study (3), social-, organizational-, technical-, legal-, financial-, time- and dynamic complexity, are used as the seven comparisons, stated in Table 10 in Appendix F. Cross-case analysis. In this table elaborations of every complexity in every case are stated. Table 4 in this section is a compact version of the extensive appendix to summarize the comparisons. The complexities can be traced back in the interview questions about the execution of SRM. The similarities and differences in the case studies will be compared with the theory as stated in the literature review at the end of this section.

Similarities
Based on the seven complexities (detail complexity has been left out) the following similarities in the field of complexity, the second research component, can be stated:

- In five out of six case projects social complexity was very difficult to manage and in two of these projects it was even the most difficult complexity. In all projects this was mainly caused by taking the different interests of stakeholders into account and adjust them to each other. Only in one case social complexity was not difficult, but the construction area was cleared from stakeholders on beforehand.
- In four out of six cases technical complexity was recognized as very difficult and in two of these projects it was even the most difficult complexity. These complexities occurred mainly because new-, unknown-, or innovative technologies were used during construction.
- In four out of six projects organizational complexity was the most difficult to manage and in two of these projects it was the most difficult complexity, just like with social- and technical complexity. This complexity was mainly caused due to difficulties in the project organizations.
- Legal complexity was in none of the projects recognized as difficult to manage. Although the complexity was present with a lot permits to request in all projects, it were all standard procedures.
- Financial complexity was also recognized as not very difficult to manage in the six case projects. In three out of six projects it was not difficult at all. In the other cases it was difficult, next to the most difficult complexity, because a fixed maximum price or the finance component in the DBFM contract.
- In four out of six cases time complexity was present, but not difficult to manage. In two cases it was difficult, next to the most difficult complexity, because of several issues in the project planning.
- Dynamic complexity was present in every project, across the other complexities. In four projects dynamic complexity was difficult to manage because of contractual changes and a lack of flexibility in the contract. In two projects it was not difficult because there were no significant changes.

Differences
The following differences can be distinguished between the six case studies in the field of complexity, based on the seven complexities (detail complexity has been left out):

- In the three cases where social complexity was very difficult this was caused by the adjustments of interests during the construction, while in the two cases were social complexity was the most difficult this was caused by the inevitable implementation of stakeholder’s interests in the design.
- There was a difference in the technical complexity in all case projects. In one case there was not enough knowledge about the material, in another case innovative construction techniques made it difficult and in two cases new types of civil works were hard to control.
- The main difference in organizational complexity between the projects was the internal contractor combination compared to the total project organization with the client. In two cases the collaboration between client and contractor within the organization was important and in two other cases the difficulties within the contractor combination caused the most difficulties.
- Legal complexity was not very difficult in all projects, but it was present. A difference was that in three cases the quantity of the permits needed attention and in two cases the procedures needed attention.
- In the three cases in which financial complexity did not cause problems in the field of SRM there was no fixed price. In the case projects with a fixed sum financial complexity caused major issues.
- In two case projects dynamic complexity caused difficulties due to the fact that the client changed its preferences. In two other case projects dynamic complexity caused difficulties because the contract was not flexible enough to implement changes without issues.
Literature review

In the literature about complexity it is stated that complexity has always been present in LIPs and the current social developments make the execution of LIPs even more complex at the moment (Verweij, 2015). This can be confirmed in all case study researches, because all issues that occurred contained complexity. Next to the importance and presence of complexity in LIPs, it can be used to prioritize issues. Literature about complexity has been developed over time and current leading resources conclude that complexity can be traced back in six types: social-, technical-, organizational-, legal-, financial- and time complexity.

Next to that there are two types of complexity which occur across the other complexities: dynamic complexity and detail complexity (Hertogh & Westerveld, 2009). All complexities were present in all case studies, although not all complexities were equally important. In the literature social complexity is recognized as the most important and dominant complexity, arising from conflicting interests of involved stakeholders. After that, technical complexity and organizational complexity are stated as very important during LIPs, due to innovative and unknown technologies and difficult project organizations. In the case studies these three complexities were also recognized as most important. In two cases (extend A1/A6 and construct A4) social complexity was the most difficult to manage, in two other cases (renovate bridge and redirect channel) technical complexity was the most difficult to manage and in the last two cases (renovate railway station and construct a new zoo) organizational complexity was the hardest to manage. Legal-, financial- and time complexity were also important in all case studies, but to a lesser extent than the other complexities.

Besides the six complexities of the practical structure, mainly dynamic complexity was also recognized in the case studies. In several case studies changes occurred during the execution of a LIP. These changes were very difficult to manage and therefore dynamic complexity is also seen as an important complexity, corresponding with the literature. This means that the findings in the case studies correspond with the findings in the literature about complexity and all complexities should be taken into account during LIPs to prioritize issues.

Concluding findings

Important issues with complexity were found in the six cases and compared with the literature study (3). The following findings are seen as the conclusion of the cross-case analysis about complexity:

First all six practical complexities as stated in the theoretical framework were present in the six case studies. All occurred issues could be linked to a complexity, although some complexities occurred to a lesser extent than others. The fact that all complexities are recognized in the cases and could be linked with the issues proves that they are very useful to categorize issues. Most issues probably fall under social- or organizational complexity, but when for example a legal issue occurs it can be more faster to solve when the category is known.
Furthermore, the fact that all occurred issues could be stated within the six complexities is a proof that the issues can be categorized. Categorizing the issues can be a helpful to divide them among the corresponding managers, accelerating the problem solving. Several issues can contain multiple complexities, these sub-issues can also be divided among the corresponding managers. The managers in a project can give priority to issues when they know to which complexity they belong, because some complexities are seen as more important than others. Therefore, prioritizing issues through complexity types is a very convenient tool in executing SRM. Next to these six practical complexities several issues occurred which could be linked to dynamic complexity. These issues mainly consisted of scope changes during the project, which emanated from changed preferences of clients or stakeholders and occurred across the other complexities. Dynamic changes are inevitable in LIPs because of the many stakeholders and long life cycle. Therefore, changes should be managed by addressing the dynamic issues in time and find appropriate solutions for them.

These findings are used for the design criteria of the solution tool and are summarized as follows:

- All six practical complexities should be taken into account when issues are being identified.
- Prioritizing issues by linking them to corresponding complexity categories is a useful tool for SRM.
- Next to the six practical complexities dynamic complexity occurs in terms of changes in the LIP.

### 4.8.3 CROSS-CASE COMPARISON IN THE FIELD OF INTEGRATED CONTRACTS

This section will elaborate the similarities and differences between the six case studies in the field of integrated contracts. Five comparisons have been found in the cases in the field of integrated contract and are stated in Table 11 in Appendix F: Cross-case analysis. In this table elaborations of every comparison in every case are stated. Table 5 in this section is a compact version of the extensive appendix to summarize the comparisons. These comparisons can be traced back in the interview questions about integrated contracts. The similarities and differences in the case studies will be compared with the theory in a literature review.

#### Similarities

Based on the five comparisons in the field of integrated contracts, which are extensively stated in Table 11 in Appendix F: Cross-case analysis and are summarized in Table 5, the following similarities between the cases are distinguished:

- In all six case studies there was a strict responsibility division between client and contractor. This was mainly caused by the characteristics of the integrated contracts, which stimulate this strict division. One exception was present in one case (construct a new zoo), were the responsibility division between the two clients was not clear, but still the division between client and contractor was clear.
- In all case studies an intended advantage of the integrated contract was expected to be: more design freedom, but the underlying tension of the contract actually obstructed the freedom in most cases.
- All the case study projects also encountered disadvantages of the integrated contracts. The lack of flexibility and static character were stated by mainly the contractor respondents as biggest obstacle.
- Although there was a strict responsibility division in the contracts of all case projects, collaboration outside the contract between client and contractor was inevitable in all cases. In some cases this was executed more intensive compared to other cases, but client and contractor always collaborated.
- A common thought about the current integrated contracts which all twelve respondents shared, was the fact that current integrated contracts are very static with no room for flexibility and collaboration inside the contract. Also all twelve respondents of the six case studies recognized that too many responsibilities are shifted to the contractor in current integrated contracts, which should be reduced.

#### Differences

The following differences between the six cases can be distinguished, based on the five comparisons in the field of integrated contracts, which are stated in Table 11 in Appendix F: Cross-case analysis and are summarized in Table 5 in this section:

- Although there was a strict responsibility division between client and contractor, several SRM managers took the initiative to collaborate and share the responsibilities outside the contract. Sharing responsibilities between both SRM managers of the client and contractor was present in three out of six cases and in all those cases it was experienced as very positive for the project.
• All contractors agreed that much design freedom is an advantage of integrated contracts, but the difference between the projects is that this freedom was not always present. For example, in two case projects the designs were already developed very far by the client. Therefore the possibility for the contractor to create more profit by designing an innovative design was restricted by the contract.

• The lack of flexibility and static character of the integrated contracts were recognized by mainly the contractor respondents as biggest disadvantage. There was a difference in the types of flexibility and static character between the cases. In two cases the lack of flexibility was created by financial reasons while in other cases the lack of flexibility was created by limitations of freedom for the contractor. Still both led to problems for the contractor to stay within the contractual terms.

• There was a big difference in the way in which client and contractor collaborated outside the contract. In three cases collaboration between the SRM manager of the client and contractor was the key factor for success through sharing responsibilities outside the contract. In the three other cases collaboration outside the contract was also important, but the responsibilities were not shared.

• Every respondent agreed that the current responsibility division in integrated contracts is very static, but they do not agree on the solution to that. Most respondents from the clients think that the current integrated contracts should be changed and most respondents from the contractor think that other contract forms like an alliance or ‘bouwteam’ are a good solution for LIPs.

<table>
<thead>
<tr>
<th>Comparison ICs</th>
<th>Case 1: Extend A1/A6</th>
<th>Case 2: Construct A4</th>
<th>Case 3: Renovate bridge</th>
<th>Case 4: Redirect channel</th>
<th>Case 5: Renovate railway station</th>
<th>Case 6: Construct a new zoo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strictness of responsibility division</td>
<td>There was a strict responsibility division in this project</td>
<td>The contract contained strict responsibility divisions.</td>
<td>The contract had a strict division, but the SRM managers shared their responsibilities</td>
<td>The contract had a strict division, but the SRM managers shared their responsibilities</td>
<td>The tasks were strictly divided between client and contractor</td>
<td>There was no clear division because there were two clients and a contractor</td>
</tr>
<tr>
<td>Advantages of the integrated contract</td>
<td>Much freedom in the design and other aspects should be a great advantage</td>
<td>The freedom to adjust the design to the construction is an advantage</td>
<td>If the D&amp;C contract was implemented in a normal way it could have much advantages</td>
<td>SRM was executed outside the contract in a kind of alliance form</td>
<td>An advantage of the D&amp;C contract should be the design freedom</td>
<td>The contractor had much freedom to create a good project within the ceiling price</td>
</tr>
<tr>
<td>Disadvantages of the integrated contract</td>
<td>The integrated contract was very static and there was no room for flexibility</td>
<td>Missinterpretations during the design phase lead to discussions and changes</td>
<td>The management contractor elaborated the design already very far</td>
<td>Flexibility and sharing tasks is difficult in this contract</td>
<td>The responsibilities were not evenly divided</td>
<td>Many changes occurred due to the changing demands of the client</td>
</tr>
<tr>
<td>Collaboration outside the contract</td>
<td>There was not much collaboration outside the contract</td>
<td>The collaboration went well in the field of SRM, but they did not share tasks</td>
<td>Collaboration in the field of SRM proved to be very successful in SRM activities</td>
<td>Both SRM managers wanted to collaborate outside the contract</td>
<td>Both SRM managers were collaborating on SRM tasks</td>
<td>The collaboration went well, but they did not share tasks or responsibilities</td>
</tr>
<tr>
<td>View on integrated contracts in general</td>
<td>Adding more flexibility and collaboration in the contract would be an improvement</td>
<td>Collaboration is inevitable to solve particular problems.</td>
<td>There is no room for flexibility which has to be added by the SRM managers</td>
<td>Much tasks lay with the contractor, while collaboration is more profitable</td>
<td>These type of projects should be executed with an alliance or in a ‘bouwteam’</td>
<td>The contractor is not always able to deal with the risks within their responsibility</td>
</tr>
</tbody>
</table>

Table 5: Cross-case comparison integrated contracts, summary (Heeringa, 2015)

Literature review
As stated in the literature, the introduction of integrated contracts causes ongoing changes in the responsibility and risk division between the public client and private contractor. There is a shifting of responsibilities to the market with the concept ‘markt tenzij’ (‘market unless’), which means that private contractors are challenged to come up with creative solutions and let go of traditional management processes. Due to integrated contracts the contractors has to execute SRM as a new task, while the client performed that task in traditional contracts (Nijpels, 2011). Another characteristic of integrated contracts is a clear separation of public- and private responsibilities. The tasks are divided according the contract causing new issues for contractors, while clients are sometimes more competent to solve the issue. In all cases the tendency of shifting responsibilities to the private market was recognized by the respondents from both client and contractor. All respondents from both client and contractor felt that at this moment too much responsibilities are shifted to the market.
Also all six case studies had an integrated contract in which all responsibilities were clearly divided between client and contractor. The way in which the SRM managers dealt with the contract was different for every LIP. In three out of six projects: renovate bridge, redirect channel and renovate railway station, the SRM managers executed SRM tasks outside the contract and shared responsibilities or risks if the project benefited from it. This resulted in good and fast solutions, with positive effects on the LIP. In the other projects a ‘stick to the plan’ policy was applied and the responsibility division was strictly respected. This resulted in long change procedures and discussions between the managers. Collaboration outside the static contract should be taken into account in the solution tool, because it is proven that it is beneficial for the LIP.

The introduction of integrated contracts had several intended added values, like: better risk division, higher quality and more collaboration. Earlier contractor involvement and awarding a contractor with multiple project phases could be beneficial for the project. Nevertheless shows the current situation that the underlying tensions of these intended added values overrule the advantages of integrated contracts (Verhees et al., 2015). In all cases the intended added values were recognized at the beginning of the project, but in also the tensions beneath these values came forward. For example the freedom for the contractor to make their own design and adjust it to their construction planning was recognized as added value. In practice this freedom was prevented because the static characteristic and strict boundaries of the contract.

The main disadvantage as stated by all respondents in the case studies is the lack of flexibility in integrated contracts. As stated in the literature, the more integrated a contract becomes, the earlier a contractor is involved and the more responsibilities are shifted to the market (Projectburo B.V., 2015). This leads to less flexibility in design freedom, collaboration outside the contract and financial boundaries. Therefore tensions instead of intended values arise in integrated contracts, as proven by all case studies. The respondents of the cases are not sure if other contract forms like an alliance or ‘bouwteam’ are solutions for the future, but the lack of flexibility definitely has to be taken into account.

**Concluding findings**

Important issues with integrated contracts were found in the six cases and literature study (3). The following findings are seen as the conclusion of the cross-case analysis about integrated contracts:

The first important finding is that the responsibility division between client and contractor according the contractual terms was very strict in all cases, just like the literature about integrated contracts implied. Nevertheless, the majority of the SRM managers from both client and contractor shared risks and responsibilities with each other outside the contractual boundaries. This was done because some issues could be solved easier together or the SRM manager who was not responsible for the issue was more competent to solve the issue. Therefore sharing risks and responsibilities outside the contract can be beneficial for the LIP.

The second finding contains the way in which the first finding can be realized, namely by sharing responsibilities according the competency to deal with issues. When risks are less strictly divided and are shared between client and contractor, a fair and obvious method should be developed. In the cases it became clear that it was beneficial for the LIPs when the organization that was most competent to tackle an issue took responsibility for it through own initiative. In the future allocating the issues to the client, the contractor or both, should be regulated by means of a tool which states the competency of client and contractor for an issue. The last finding about integrated contracts is the fact that there is no flexibility in these contracts, while the long life cycles and dynamic complexity inevitably cause changes during LIPs. This means that during LIPs the contract can impossibly stay the same without getting conflicts about the changes. Therefore many conflicts could be resolved when flexibility in the contract is added. If the contract could be adjusted to the changes during a LIP the client and contractor could save a lot time and legal confrontations with each other.

These findings are used for the design criteria of the solution tool and are summarized as follows:

- Sharing risks and responsibilities outside the contractual boundaries can be very beneficial for the LIP.
- The competency of a client or contractor to deal with an issue can be the criterion to divide an issue.
- More flexibility in integrated contracts can loosen up the strict responsibility division.
5. SOLUTION TOOL

In this chapter a potential solution in the form of a tool will be developed in order to support this research in solving the problem statement (2.1). The tool will be a practical model, which should be used to support SRM activities. The information from the literature study (3) and case study research (4) will be combined to create the solution tool. In the first paragraph the concluding findings from the cross-case analysis (4.8), which have been compared with the theoretical framework (3.4.4), will form the design criteria for the solution tool. In the second paragraph the development of the solution tool will be elaborated, with the design criteria as a guideline. The third paragraph of this chapter will elaborate the components of the tool separately. The last paragraph of this chapter consists of an instruction manual, which states how the solution tool should be used.

5.1 DESIGN CRITERIA FOR THE SOLUTION TOOL

This paragraph will elaborate the design criteria for the solution tool. The design criteria are based on the findings from the theoretical framework (3.4.4) and cross-case analysis (4.8). The criteria are divided over the three research components, just like the rest of the research.

5.1.1 DESIGN CRITERIA SRM

In the current society it is impossible to implement a LIP, without having large influence on the environment. The environment has a large impact on the LIP in return. In this environments stakeholders are involved with different and changing interests, which cause issues for the LIP (Clafis, 2015). Managing stakeholder’s interests has always been a task in LIPs, but since SRM is a separate discipline more researches are done (KING, 2010). The following criteria emanate from issues and findings on this core problem from the literate and case studies:

1. **Standard method to execute SRM.** In the literature increasingly more methods and approaches are developed to execute SRM. In the case studies it became clear that all SRM managers are in need of a good approach which can standardize SRM activities, surpassing the current methods.

2. **Collaboration between client and contractor.** In the current literature about executing SRM, no literature about collaboration between client and contractor was found. This can be seen as a missing link in the current literature, because it was recognized as the key factor for success in three case studies where much collaboration occurred.

3. **Participation with stakeholders.** Although participation is recognized as separate working field of SRM by a few literature sources, it has not been elaborated very much in literature. In five out of six case studies participation with stakeholders played a positive role to execute the LIP. It is impossible to ignore the interests of surrounding stakeholders in the current society, without causing major issues.

5.1.2 DESIGN CRITERIA COMPLEXITY

Although complexity has always been present in LIPs, it is becoming increasingly important due to the current social developments. LIPs are getting more complex in practice in technical-, social-, organizational-, legal-, time- and financial ways (Hertogh & Westerveld, 2009). Furthermore, increasing dynamic complexity causes scope changes during the long life cycle of LIPs, while the contracts are static (Verweij, 2015). The following criteria emanate from issues and findings about this core problem from the literate and case studies:

4. **Six practical complexities.** In the literature about complexity six types of complexity are distinguished in practice by leading resources. During all LIPs in the case studies these six complexities were present, but not always with equal importance. Therefore all complexities should be taken into account to cope with, by means of using the solution tool.

5. **Prioritizing issues.** By categorizing issues in LIPs in the six complexities they can be solved faster by the corresponding manager and linking a complexity to an issue makes prioritizing easier. Also one large issue can contain several complexities, creating sub-issues which should be managed.

6. **Dynamic complexity.** In LIPs changes are inevitable due to the long lifespan and changing interests as stated in theory. This was confirmed in the case studies, were dynamic changes caused several issues. Detail complexity has not been recognized in literature and case studies for causing issues in LIPs. Therefore dynamic complexity should be taken into account, across the six practical complexities.
5.1.3 DESIGN CRITERIA INTEGRATED CONTRACTS

The introduction of integrated contracts caused ongoing changes in the responsibility division between clients and contractors. The intended added values of the contracts are at the current moment overruled by the underlying tensions (Verhee et al., 2015). The static character of integrated contracts makes that the intended freedom and innovation is suppressed. The clear division causes that several issues or risks are the contractor’s responsibility while the client is more competent to deal with it, or the other way around (Wassenaar, 2015). The following issues and findings on this core problem have been found in the literature and cases studies:

7. **Sharing risks and responsibilities.** In the theory about integrated contracts it is clearly stated that the responsibilities are strictly divided between client and contractor. Nevertheless it became clear from the case studies that sharing risks and responsibilities could be beneficial for the LIP. Therefore sharing responsibilities and collaboration outside the contract should be taken into account.

8. **Competency to deal with issues.** In the literature it becomes clear that the responsibilities are divided according to the UAV-GC 2005 guidelines. In three out of six case studies the SRM manager took on issues outside their responsibility, because they felt responsible for it. Several issues were divided in advance, while it became clear that the other side was more competent to bear the risk, or sharing the risk is most beneficial. Competency to deal with issues should be taken into account in advance.

9. **Flexibility instead of strictness.** Not much has been found in the theories about flexibility in integrated contracts. From the cross-case analysis it becomes clear that the lack of flexibility in the integrated contracts was seen as a large disadvantage. Strict boundaries in project budget and design possibilities are obstructing freedom and innovation for the contractor.

5.2 DEVELOPMENT OF THE SOLUTION TOOL

In this paragraph the development of the solution tool will be declared, guided by the design criteria of the previous paragraph. The design criteria from SRM will have the numbers 1, 2 and 3, the design criteria from complexity are numbered with 4, 5 and 6 and the design criteria from integrated contracts are numbered with 7, 8 and 9. These numbers are stated in Figure 20, which visualizes the developed solution tool in one image. For every design criterion it is stated if it is derived from literature, case studies or both and after that the corresponding part in the solution tool will be explained.

1. **Standard method to execute SRM**
   A standard method for the execution of SRM is the first criterion and originates from both the literature study (3) and case study research (4). This criterion is stated in the general conclusion of the literature study about SRM and is also part of the theoretical framework (3.4). It is a returning step plan for the execution of SRM, found in several current approaches, like SOM. The criterion is also mentioned in the case study research, because the respondents indicated that a standard method for SRM would be an improvement for the execution. Therefore it is chosen to use this step plan for the execution of SRM as the base of the solution tool. The standard method to execute SRM is indicated with the number 1 in Figure 20 and consists of the same step-based plan as stated in the theoretical framework.

2. **Collaboration between client and contractor**
   The second criterion concerns the collaboration between client and contractor in the execution of SRM and emanates from the case study research (4). In the literature not much could be found on collaboration between client and contractor in the field of SRM, mainly because SRM was executed in an integrated contracts in which the responsibilities were strictly divided. Nonetheless, it was recognized in the case studies to be a key factor for success in the execution of SRM. In LIPs were SRM managers of client and contractor collaborated a lot, the execution of SRM went very well and joint solutions were applied. Therefore collaboration is added in the solution tool as collaborative engagement. This is indicated with the number 2 in Figure 20 and is part of a developed ‘responsibility grid’, which will be elaborated in the next paragraph as separate component.

3. **Participation with stakeholders**
   Participation with stakeholders is the third design criterion and emanates from the case study research (4). Although there is several literature about participation and RWS even recognizes it as a separate working field
of SRM, it has not yet been implemented in the current methods to execute SRM. Stakeholder participation was implemented in five out of six case studies because it was inevitable in some cases and in other cases it had added values in solving issues. Therefore participation is added in the solution tool as participative engagement, to let the SRM managers participate on the necessary issues. Participative engagement is indicated with the number 3 in Figure 20 and is also part of the developed ‘responsibility grid’, which will be elaborated in the next paragraph as separate component.

4. Six practical complexities
Out of the literature study (3) it is concluded that six complexities can occur in practice in LIPs, they are the fourth design criterion. All complexities also occurred in all case studies, but they clearly emanated from the theory about complexity. Nevertheless the occurrence of all complexities in the cases proves that they should all be taken into account and used to categorize the issues. The six complexities are added in the solution tool as part of a developed ‘issue-complexity matrix’, which will be further elaborated in the next paragraph and are stated with number 4 in Figure 20. All complexities will have different colors to clarify the difference.

5. Prioritizing issues
Out of the case study research (4) this criterion emanated from the fact that most issues took a long time to resolve. By categorizing the issues in the six complexities a corresponding manager can be found faster. Linking an issue to a complexity makes it easier to prioritize it, because for example a social complexity is generally more important than a legal complexity. It is also possible that an issue contains multiple complexities, which bring sub-issues that could be engaged by different managers. Therefore it is important to prioritize the issues to develop a better engagement plan. This prioritization is executed in the developed ‘issue-complexity matrix’, which will be elaborated in the next paragraph. Number 5 in Figure 20 states this prioritization in the matrix.

6. Dynamic complexity
The last criterion of complexity is dynamic complexity and originates from the literature study (3) and case study research (4). Dynamic complexity is seen as part of the scientific structure of complexity in literature and occurs across the other six complexities. This includes dynamic changes due to changing interests of the client or stakeholders and the long lifespan of LIPs. These changes indeed occurred in the most case study researches and in several cases changing demands of a client were seen as very difficult to manage. Therefore dynamic complexity is added to the solution tool as a horizontal step alongside the step-based plan, which can occur in every step and assures that the step-based plan should start over. This is shown with number 5 in Figure 20.

7. Sharing risks and responsibilities
This criterion concerns the responsibility division in integrated contracts and is emanated from the case study research (4). Sharing responsibilities is not mentioned in theory, but from the case study researches it became clear that several SRM managers of clients and contractors shared responsibilities outside the contract. This was beneficial for engaging issues in the LIP. Sharing responsibilities was based on who was most competent to tackle the issue, or felt most responsible to solve it. Therefore sharing risks and responsibilities is taken into account in the solution tool through the developed issue-competency matrix, which will be elaborated in the next paragraph. Linking issues to responsibility outside the contract leads to sharing risks if both SRM managers are competent to tackle the issue. Number 7 in Figure 20 shows this relation in the ‘issue-competency matrix’.

8. Competency to deal with issues
This criterion further elaborates the previous criterion and also emanated from the case study research (4). When both SRM managers of the client and contractor indicate in advance if they are competent or feel responsible to take on the risk, issues could be solved more easily. If both SRM manager are competent or feel responsible to tackle issues, they can be shared. This competency to deal with issues is the outcome of the ‘issue-competency matrix’ which is indicated with number 8 in the solution tool in Figure 20.

9. Flexibility instead of strictness
Flexibility is stated as one of the intended added values of integrated contracts in the literature, but it became clear from several examples in the case studies that there is actually a lack of flexibility. The criterion emanates from the literature study (3) and case study research (4). It became clear that the lack of it causes issues.
The responsibility for issues can shift during the LIP and freedom in the contract could help. The shifting is shown as number 9 in Figure 20 in the developed ‘responsibility grid’ and will be elaborated in the next section.

**Visualization of the solution tool**

1. Standard method to execute SRM
2. Collaboration client & contractor
3. Participation with stakeholders
4. Six practical complexities

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**Figure 20: Visualization of the solution tool (Heeringa, 2015)**
5.3 SEPARATE COMPONENTS IN THE SOLUTION TOOL

In this paragraph the separate components of the solution tool, which have already been stated in the development of the tool, will be explained. The step-based plan which forms the base of the solution tool has already been elaborated in the literature study (3) and will therefore not be elaborated again. The tools which are used to support this base as visualized in the solution tool in Figure 20 will be explained. At first the three tools: ‘responsibility grid’, ‘issue-complexity matrix’ and ‘issue-competency matrix’ will be elaborated. After that the tools are visualized on a noticeable scale.

Responsibility grid

The responsibility grid as stated in Figure 21 emanated from the first thought to solve the strict responsibility division in integrated contracts. By talking with respondents during the case studies it became clear that a tool to divide or share issues, which could be engaged accordingly, has not been developed in practice. Therefore a quartered grid is created with two axes: responsibility of the contractor and responsibility of the client, in which both client and contractor can score their responsibility for particular issues.

Scoring issues with responsibility is done with the marks 0 to 10, in which 0 is the lowest responsibility and 10 the highest. It is important to notice that it not concerns the responsibility as stated in the contract, but it is about who should take the responsibility, independent of the contract. If for example the client scores low responsibility on a particular technical issue and the contractor scores high responsibility, this issue falls in the quadrant of ‘contractor engagement’. This means that the contractor is responsible to deal with the issue and if it is the other way around the client is responsible, due to the fact that the issue falls in ‘client engagement’. If both client and contractor score high responsibility the issue falls in the quadrant of ‘collaborative engagement’ and they should deal with the issue together. If a stakeholder for example does not form a treat and both client and contractor do not feel responsible, the issue falls in ‘participative engagement’. This is the quadrant where most issues arise before they go to another quadrant and were nobody feels responsibility for, which makes participation very important. This tool can be applied in the step-based SRM model to determine the stakeholder engagement, but the values from 0 to 10 which indicate the responsibility of the client and the contractor must come from the ‘issue-complexity matrix’ and ‘issue-competency matrix’.

Issue-complexity matrix

This is a matrix in which issues in the LIP can be stated and linked with one of the six practical complexities. It is stated in Figure 22 and the matrix emanated from the fact that every issue contains one or more of the six complexities. The complexities are taken from the theoretical framework and are all given a separate color. An issue can hold multiple complexities and therefore creates sub-issues which can be separately put in the responsibility grid. This prioritizes the issues and causes that one issue can have sub-issues which have a different responsibility division. The scores from 0 to 10 of a particular issue, which emanate from the ‘issue-competency matrix’, will be entered in the ‘issue-complexity matrix’ beneath the corresponding complexities. It is important to notice that this matrix has to be completed in consultation, because only in that way both client and contractor can be satisfied about the responsibility division and corresponding complexities. After that the issues will be added in the responsibility grid, in the corresponding color of the complexity, to visualize the total responsibility division of issues.

Issue-competency matrix

This matrix is used to state the issues and link them to the competencies of the client and the contractor. Some additional literature is used to develop this tool and will therefore be elaborated beneath Figure 23, in which the tool is stated. For every issue the contractor and the client give themselves a mark between 0 and 10 on every set of skills, which will express the extent to which they feel competent to use this set of skills in a particular issue. This average mark will be the input for the ‘issue-complexity matrix’ and ‘responsibility grid’ to rank an issue on responsibility. It is important to notice that the marks should be filled in in consultation, because otherwise managers strategically could give a difficult issue a low mark, while they are the most competent to deal with it. The managers should not give the marks based on themselves, but based on the whole profile of their organization. If a manager scores low on technical-, personal-, or strategic skills that does not mean that the organization is not competent to deal with the issue according these skills.
Figure 21: Responsibility grid (Heeringa, 2015)
### Figure 22: 'Issue-complexity matrix'

<table>
<thead>
<tr>
<th>Issue</th>
<th>Complexity</th>
<th>Social complexity</th>
<th>Technical complexity</th>
<th>Organizational complexity</th>
<th>Legal complexity</th>
<th>Financial complexity</th>
<th>Time complexity</th>
</tr>
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<tbody>
<tr>
<td>A:</td>
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</tbody>
</table>
The ‘issue-competency matrix’ is shown in Figure 23 and is based on literature in the field of risk management. An organization called Risk and Insurance Management Society (RIMS) developed a ‘core competency model’ out of practical and theoretical risk management models to measure the competency of a manager (RIMS, 2007). The ‘core competency model’ can be used to define positions, communicating, personal development and more and is based on three sets of skills. The goal of the organization is to evaluate and adjust the model every three years, because of the fast changing management environments, which creates a dynamic instead of static approach. Different names are given to the sets of skills to make it compatible for this research, which resulted in the following three sets of skills: technical skills, personal skills and strategic skills. The three sets of skills are seen as equally important, which excludes the use of weight factors. The participants who fill in the marks should be up to date about the industry of their organization and its developments, to create fair values. Also the marks are supposed to be filled in through consultation between client and contractor. Both client and contractor should argue about each other’s skills and come to a joint mark, which satisfies both organizations. The three sets of skills for which a mark has to be filled in are elaborated as follows:

- **Technical skills:** The operational layer of skills in which the traditional tasks and specialized skills of the contractor or client come forward. A central question which can be asked to evaluate these skills is: do I have the best technical knowledge and expertise to tackle this issue? Key words to evaluate these skills are: expertise, controllability, feasibility and project oriented.

- **Personal skills:** These are the so called ‘soft’ management skills of the contractor or client, which form the basics of people management. A central question which can be asked to evaluate these skills is: how eager do I want to solve this issue? Key words to evaluate personal skills are: motivation, enthusiasm, innovation and experience.

- **Strategic skills:** This is the strategic layer of skills in which the value of issues are estimated and managers have to sense whether the tasks fit together. A central question which can be asked to evaluate these skills is: How important is this issue and which consequences does it have? Key words to evaluate strategic skills are: prioritize, planning, decision making and estimating consequences.

**Figure 23: ‘Issue-competency matrix’**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Contractor</th>
<th>Client</th>
<th>Technical skills</th>
<th>Personal skills</th>
<th>Strategic skills</th>
<th>Average competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>B:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>C:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>D:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>E:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>F:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>G:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>H:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>I:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>J:</td>
<td>Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
</tr>
</tbody>
</table>
6. FEEDBACK MEETING AND ADJUSTMENTS

This chapter will evaluate and adjust the developed solution tool. It is important to evaluate the solution before it can be used in practice, to prevent possible errors and apply improvements. Furthermore, it is important for the conclusion and recommendations of this report that the solution for the problem statement is accurate. At first, the evaluation meeting which has been held by means of a workshop, will be elaborated and the evaluation and suggested adjustments for the tool are stated. The second paragraph visualizes the adjusted solution tool on a noticeable scale. The last paragraph is an instruction manual, which states how the adjusted tool should be used and shows the separate components filled out according to an example case.

6.1 FEEDBACK MEETING BY MEANS OF A WORKSHOP

After the case study researches were finished and the model was developed, a feedback meeting was organized with the intention to evaluate the developed solution tool. Around twenty persons were invited to participate in a workshop on the 30th of November 2015 at the office of VolkerInfra in Vianen. The workshop lasted one and a half hour and after that half an hour was used as evaluation session. The workshop consisted of the application of the developed tool on a current case project (Construction of the new sea lock near Terneuzen). The workshop was held in Dutch and the elaboration can be found in Appendix G: Tool Workshop, nieuwe sluis Terneuzen.

Most of the invitees were respondents of the interviews from the case study research and were already familiar with the research topic and the development of the model. The other invitees were employees of a private or public organization which are associated with the construction of LIPs. The invitees who were not respondents of the interviews saw the research model for the first time, but they were familiar with SRM. Therefore, an objective group of participants was gathered to create a good evaluation of the tool. Eventually four respondents of the interviews participated (consisting of three contractors and one client) and one project manager of a water board joined the workshop. The researcher himself played as a client as well to create an equally divided group of six participants, consisting of three participants who could play contractor and three participants who could play as a client. The managers were given roles in three groups of two, in which one participant represented the contractor and the other one represented the client.

At first, the groups were asked to read the project description and the first round: the design phase. After that they had to follow the step-based plan of the developed model and fill in the ‘issue-competency matrix’, ‘issue-complexity matrix’ and ‘responsibility grid’ accordingly. The values in the matrices were filled out in consultation between the client and contractor, because this logically followed from using the tool in practice. The next step was to read the second round about the construction phase and follow the step-based plan again. This round and the third round could not be completed, because of a lack of time. An example of a filled out ‘responsibility grid’ is stated in Appendix G: Tool Workshop, nieuwe sluis Terneuzen in Figure 37.

6.1.1 EVALUATION OF THE TOOL AND SUGGESTED ADJUSTMENTS

The participants were asked to what extent the tool could solve issues in SRM in practice. In general the participants saw much potential in the use of the tool to solve SRM issues in practice. Nevertheless, the following improvements were suggested to make the model even more applicable in practice:

- Added values of the ‘issue-complexity matrix’ are to prioritize the issues and let sub-issues come to the light. Therefore this tool should be used first, before the other steps are taken.
- By swapping both matrices it is not possible to state numbers in the ‘issue-complexity matrix’, therefore the boxes can be used to state the created sub-issues.
- A diagonal line through the participation and collaboration quarters in the ‘responsibility grid’ should indicate who takes the lead with a particular issue. Some issues in those quarters will end up very close to ‘client engagement’ or ‘contractor engagement’ which should take the lead accordingly.
- The more detailed an issue was described, the more complexities emerged. This can be desirable in an advanced stadium of the project, but during the early phases issues should be broadly described.
- It depends on the project phase in which the issue is addressed whether a manager is competent or feels responsible to tackle it. Therefore the model should be regularly revised during a LIP.
6.2 VISUALIZATION OF THE ADJUSTED TOOL

The model will be called ‘DRD-tool’ from now on, which stands for: ‘Desired Responsibility Division tool’. The adjustments led to the following improved final solution tool as stated in Figure 24:

1. Standard method to execute SRM
2. Collaboration client & contractor
3. Participation with stakeholders
4. Six practical complexities

Figure 24: Final ‘Desired Responsibility Division tool’ (Heeringa, 2015)
6.3 INSTRUCTION MANUAL FOR THE ‘DRD-TOOL’

This paragraph is an instruction manual to explain how the ‘DRD-tool’ should be used step by step. The manual is based on the final model which is adjusted and stated in Figure 24. Also the sub-tools are adjusted according the previous paragraph, therefore all components of the ‘DRD-tool’ will be visualized at the end of this paragraph. They are filled out according one of the case study researches of this thesis (Extension of two highways, A1/A6 Almere-Diemen Havendreef) to serve as an example of how the tool should work.

6.3.1 STEP-BASED PLAN FOR THE ‘DRD-TOOL’

The instruction manual corresponds to the step-based plan of the ‘DRD-tool’ except for the step ‘stakeholder mapping’ because this is an independent step, although it is an important step in the execution of SRM. For the step ‘stakeholder mapping’ an existing project management tool like a power/interest grid could be used. Furthermore the names of some steps are slightly adjusted to let them correspond to the use of the tools.

Step 1: Identify issues
The first step consists of stating issues which arise in a LIP in the ‘issue-complexity matrix’ as shown in Figure 25 and when issues are eventually solved they can be removed. Both client and contractor should search for one complexity or more corresponding complexities in an issue in consultation with each other. This can be done by for example two SRM managers in a LIP, like during the workshop, but the tool can be used by other managers which have the same function as well. Conditions to use the tool are that both managers should be equally important and are confronted with the same issues in the same LIP. Furthermore both managers should work for two organizations which have a responsibility division between each other, for example a public client and a private contractor. In the ‘issue-complexity matrix’ sub-issues arise from the multiple found complexities per issue. The found sub-issues per complexity should be stated in the corresponding boxes below the corresponding complexities. The issues are now identified and categorized in corresponding complexity types.

Step 2: Prioritize issues
The sub-issues which have been found and categorized in complexity types should be stated in the ‘issue-competency matrix’ as shown in Figure 26. The prioritization must be completed by giving scores according the competency of a manager to tackle the issue. Both client and contractor should state for every issue how competent their organization is by means of technical-, personal- and strategic skills to deal with the issue, with a mark from 0 to 10. The average of these marks represents the total desired responsibility of the client and the contractor to take on the issue. Desired responsibility means that the scores represent the competency in the most desired situation and not how the responsibility is actually divided by the contract. It is also important that this matrix is completed in consultation, otherwise managers strategically could give a difficult issue a low mark, while they are the most competent to deal with it. The managers should not give the marks based on themselves, but based on the whole profile of their organization.

Step 3: Desired engagement
The output of the ‘issue-complexity matrix’ and ‘issue-competency matrix’ is a set of issues in the color of the corresponding complexity, with two corresponding values for the desired client and contractor responsibility. This is the input which should be entered in the ‘Desired Responsibility Division grid’ as stated in Figure 27. With the given values the issues will end up in one of the four quarters, which visualizes if the issue should be engaged by the client, the contractor, in collaboration or in participation with stakeholders. The ‘DRD-grid’ is used as an instrument, which facilitates discussions between client and contractor on the desired responsibility division and the actual contractual responsibility division. If an issue ends up in the red or green quadrant the client or contractor should take the lead according the position of the issue relative to the diagonal line.

Step 4: Evaluation and changes
During the implementation of the engagement of the issues according the ‘DRD-tool’ both managers who completed the matrices should evaluate the process. New issues or changes could arise during such evaluation sessions. Changes inevitably occur during a LIP, which is stated in the ‘DRD-tool’ as dynamic complexity. When changes occur during the step-based plan the manager should start over and begin at step 1 to identify the new issue. The client and contractor should look into the contract together to make these changes possible.
**Step 5: Adjustments/Flexibility**

If changes occur the matrices and ‘DRD-grid’ should be adjusted to the new situation. In that way the tool stays up to date and both managers have a motivation to start new discussions. This can be done by revising the tool every time a change occurs, or by regularly use the tool and treat multiple issues at once. Flexibility should be added in the ‘DRD-tool’ by using the tool repeatedly during the project. When the ‘DRD-tool’ should be used again to start discussions and evaluate the responsibility division, depends on the LIP and the corresponding construction phase. If in a particular construction phase of a LIP much issues occur, it can be necessary to use the tool at every weekly construction meeting. On the other hand it may be more appropriate to use the tool only once a year in the maintenance phase of a particular LIP. In this way it becomes clear if issues are shifting to another quadrant and it will be noticed if issues are solved or new issues arise. This flexibility of shifting issues according responsibilities creates more freedom in the project and should lead to contractual changes. Regularly using the tool can be furthermore used to ensure that client and contractor are obligated to talk about the issues with each other from time to time.

### 6.3.2 SIDE NOTES TO TAKE INTO ACCOUNT

**Possible improvements suggested by supervisors**

Before the side notes it is important to notice that next to the participants, the supervisors of this research also suggested several improvements for the tool. These improvements were also taken into account by adjusting the model to come to the final ‘DRD-tool’. The following remarks are processed in the adjustments:

- The ‘issue-competency matrix’ should have an overarching description, stating that it must be filled in from the perspective of the organization and from the perspective of what is needed for the project.
- The model should be used to visualize the desired responsibility division, in order to show who should take responsibility according the model, instead of the responsibility as stated in the contract.
- Issues often arise in the participation quadrant, from where they continue to other quadrants. These crucial issues are not engaged yet, therefore the red and green colors in the grid should be switched.
- The link with contractual agreements should not be forgotten, although it is a separate matter. The desired responsibility does not say anything about what is possible in the contract.
- Naming the tool will contribute to a better understanding and can trigger managers to use it.

**Important side notes**

At first, it must be explained why the adjusted tool is called ‘DRD-tool’. As stated in the possible improvements a name can trigger managers to make use of it. Therefore it is chosen to use the words: desired responsibility division, because this is the main goal of the tool: to create a desired responsibility division between client and contractor and to solve issues in executing SRM accordingly. ‘DRD-tool’ is a collective name for all components: the step-based plan, ‘issue-complexity matrix’ and ‘issue-competency matrix’ as shown in Figure 24.

Furthermore, it is important that both client and contractor should keep in mind that the values will visualize the desired responsibility division outside the contract and should be filled in accordingly. In that way the contractual boundaries are forgotten temporarily and the ideal image is sketched. Whether the desired responsibility division is also possible within the contractual boundaries should be checked afterwards. If the desired responsibility division fits within the contractual boundaries it can be applied directly, but if the division does not match the contract a discussion about changes should be started by the contract managers.

Next to that, client and contractor should fill out the values in consultation, otherwise managers strategically could give low marks, while they are the most competent. When both managers start a discussion about each other’s competency marks the matrices are filled out in a fair way. They cannot give too high or too low marks to an issue to influence the end result in their favor, because the other organization has to approve it.

Finally, it should be noticed that the ‘DRD-tool’ should not be used as the solution for the found issues, but as an instrument to facilitate discussions about the responsibility divisions. In that way the managers of both client and contractor are forced to talk about the issues with each other and they cannot point at each other afterwards, because they filled out the tool in consultation. The ‘DRD-tool’ is therefore clearly a tool, instead of a solution, to help solving issues in the execution of SRM.
### 6.3.3 ADJUSTED ‘ISSUE-COMPLEXITY MATRIX’

**PROJECT NAME: A1/A6 Diemen - Almere Havendreef**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Complexity</th>
<th>Social complexity</th>
<th>Technical complexity</th>
<th>Organizational complexity</th>
<th>Legal complexity</th>
<th>Financial complexity</th>
<th>Time complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Neighboring construction organizations at junction Diemen</td>
<td>A1: Maintain good contact with SPM managers of neighbors</td>
<td></td>
<td></td>
<td>A2: Arrange construction permits on neighboring terrains</td>
<td></td>
<td></td>
<td>A3: Adjust execution planning to neighboring organizations</td>
</tr>
<tr>
<td>B: Rugstreepd at junction Diemen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C: House boats in the Amsterdam-Rijn Channel</td>
<td>C1: Gain trust among the residents of the house boats</td>
<td></td>
<td></td>
<td></td>
<td>B1: Arrange investigation to Rugstreepd for permits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D: Residents of the Bloemendael polder</td>
<td>D1: Talk with the residents about promised and actual agreements</td>
<td></td>
<td></td>
<td>D2: Evaluate the agreements of RWS with the residents and the agreements with the contractor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E: Aqueduct in the ‘Vecht’</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E2: Who pays for the suffered damage?</td>
</tr>
<tr>
<td>F: Railway crossing ProRail</td>
<td>F1: Arrange construction windows with ProRail</td>
<td>F2: Construct a new bridge which replaces the old bridge in a few days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G: Service area ‘Hackelaar’</td>
<td>G1: Arrange design complexities with current gas stations</td>
<td>G2: Connect the service area to the rest of the LIP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>G3: How much should the gas stations pay for the new services area?</td>
</tr>
<tr>
<td>H: Recreation beach ‘Zilverstrand’</td>
<td>H1: Solve issues with the actual owner about the design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I: Project organization SAAone is very extensive</td>
<td>I2: Maintain good contact with internal colleagues</td>
<td>I1: Create more structure in the project organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J: WOG difficult before deadline due to F component in DBFM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>J1: Trustworthy investors have to finance the whole LIP</td>
</tr>
</tbody>
</table>

Figure 25: Adjusted ‘issue-complexity matrix’ (Heeringa, 2015)
### 6.3.4 ADJUSTED ‘ISSUE-COMPETENCY MATRIX’

**PROJECT NAME: A1/A6 Diemen - Almere Havendreef**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Competency</th>
<th>Technical skills</th>
<th>Personal skills</th>
<th>Strategic skills</th>
<th>Average competency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1: Maintain good contact with neighboring SRM managers</td>
<td>Contractor</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3.7</td>
</tr>
<tr>
<td>A2: Arrange construction permits on neighboring terrains</td>
<td>Contractor</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>A3: Adjust execution planning to neighboring organizations</td>
<td>Contractor</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3.7</td>
</tr>
<tr>
<td>B1: Arrange investigation to Rugstreeppad for permits</td>
<td>Contractor</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>4.0</td>
</tr>
<tr>
<td>C1: Gain trust among the residents of the house boats</td>
<td>Contractor</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>C2: Arrange permits to let the house boats be removed</td>
<td>Contractor</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>D1: Talk with residents about promised and actual agreements</td>
<td>Contractor</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>D2: Evaluate agreements of RWS with the residents and vice versa</td>
<td>Contractor</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>E1: Create solutions for unexpected failures</td>
<td>Contractor</td>
<td>9</td>
<td>8</td>
<td>5</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>5.7</td>
</tr>
<tr>
<td>E2: Who pays for the suffered damage?</td>
<td>Contractor</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>6.3</td>
</tr>
<tr>
<td>F1: Arrange construction windows with ProRail</td>
<td>Contractor</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>F2: Construct a new bridge replacing the old bridge in a few days</td>
<td>Contractor</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>Client</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>8.0</td>
</tr>
</tbody>
</table>

*Figure 26: Adjusted 'issue-competency matrix' (Heeringa, 2015)*
6.3.5 ADJUSTED ‘DESIRED RESPONSIBILITY GRID’

Figure 27: Adjusted ‘Desired Responsibility Division grid’ (Heeringa, 2015)
7. CONCLUSION AND RECOMMENDATIONS

This last chapter will conclude the research and state recommendations to conduct future research in this field. The research has the objective to understand the current issues on complexity and integrated contracts which influence SRM and create a solution to improve the execution of SRM in LIPs. This will be accomplished by answering the main research question:

What contributes in solving issues with complexity and integrated contracts in Stakeholder Relationship Management during Large Infrastructure Projects?

7.1 CONCLUSION

The main research question will be answered by answering all sub-questions first. After that a discussion will evaluate the research by determining the strengths and limitations.

How can SRM, complexity and integrated contracts in LIPs be defined and what do they entail?

SRM is acknowledged as a discipline in LIPs by governmental- and private organizations since several years, which have embedded it in their project teams. The definition of SRM is shaped out of different resources as follows: “The involvement of all relevant stakeholders in a project and alignment of contradicting or supporting demands and wishes to reach shared goals” (Heeringa, 2015). The practical structure of SRM can be divided in five working fields: stakeholder management, communication, participation, conditioning and traffic management. Several standard methods have been developed recently to structure SRM or support the tasks. None of the methods are used as the standard guideline for the execution of SRM activities yet. Leading approaches are the IPM model of RWS and the SOM approach of Marc Wesselink. A general systematic structure which they have in common is a step-based plan, which will also be used as the input from SRM for the theoretical framework.

Although complexity has always been present in LIPs, it becomes more and more important because of the rapid developments in LIPs, which become increasingly complex. Also the introduction of integrated contracts caused an extension of the lifecycle in LIPs, which makes changes in long term LIPs inevitable. Complexity is defined with different resources as: “the measure of the difficulty with a variety of interconnect parts in terms of people, products and processes” (Heeringa, 2015). Different schools of thought elaborated concepts for project complexity, which eventually led to a division in two structures. Detail- and dynamic complexity form the scientific structure and social-, technical-, organizational-, legal-, financial- and temporal complexity form the practical structure. All these complexity types can influence LIPs and are therefore used as input variables from complexity for the theoretical framework.

The introduction of integrated contracts emanates from a new market approach in contracting by the Dutch government. This revolution under the concept ‘markt, tenzij’ had the consequence that the responsibility division between client and contractor is changing. Many responsibilities are shifted to private contractors who have to execute new tasks including SRM. The intention of integrated contracts was that they should have added values in the efficiency of executing LIPs by integrating multiple building phases and activities in one contract. Underlying tensions occur instead of the intended added values in quality, collaboration and financing aspects. The more integrated a contract becomes, the more responsibilities are shifted to the contractor and strict responsibility division grows. This division leads to discussions between client and contractor, creating the input from integrated contracts for the theoretical framework: responsibility of the client, responsibility of the contractor, responsibility of both and responsibility from traditional to integrated contracts.

The final conclusion of the literature study (3) is a theoretical framework, which is a combination of the findings from the three research components. The framework visualizes the most important findings in Figure 28:
How are SRM, complexity and integrated contracts approached in practice?

The importance of SRM was acknowledged in all case studies by all clients and contractors. Standard methods to structure SRM were mainly used by public clients in the cases. The contractors all executed SRM based on personal experiences, but they acknowledged that a standard method would be beneficial. Collaboration with the client was crucial in the cases, because in the three cases where collaboration with the client was high, it was recognized as the key factor for success. Participating with stakeholders was also important in the case studies. In four out of six cases the SRM managers had to participate with stakeholders in order to execute the LIP. Crucial issues in the execution of SRM occurred in stakeholder management. Main difficulties were contractual changes and misinterpretation of agreements between client, contractor and stakeholders.

All issues that occurred contained one or more of the six practical complexity types, although not every complexity was equally important. In two cases social complexity was the most important, in two other cases technical complexity important and in the last two cases organizational complexity was the hardest to manage. Legal-, financial- and time complexity were also important, but to a lesser extent than the other complexities. The fact that all occurred issues could be stated within the six complexities is a proof that the issues can be categorized. Several issues can contain multiple complexities, these sub-issues can also be divided among the corresponding managers. The managers in a project can give priority to issues when they know to which complexity they belong, because some complexities are seen as more important than others. Next to the six complexities of the practical structure, dynamic complexity was recognized in the cases. In most case studies changes occurred during the execution of a LIP, which caused issues.

In all cases shifting responsibilities to the private market due to the introduction of integrated contracts was recognized by the respondents. All respondents from both client and contractor felt that at this moment too many responsibilities are shifted to the market. Responsibilities were strictly divided in all cases, but in three out of six projects the SRM managers executed SRM tasks outside the contract and shared responsibilities. This resulted in solutions, which were beneficial for the LIP. Therefore, sharing responsibilities outside the contract should be used more in the future, to solve issues faster. In all cases the intended added values of integrated contracts like design freedom were recognized at the beginning of the project, but the underlying tensions came to the light mainly because the static characteristic and strict boundaries of the contract. The main disadvantage as stated by all respondents in the case studies is the lack of flexibility in integrated contracts.
These findings and issues were reviewed with the findings from the literature study and resulted in nine design criteria for the development of the solution tool:

Design criteria that emanated from the findings and issues about the research component SRM:

10. **Standard method to execute SRM.** This criterion originated from the literature study and case studies. In theory a returning step-based plan was found in currently developed methods. It became clear from the cases that all SRM managers are in need of a good approach which can standardize SRM tasks.

11. **Collaboration between client and contractor.** This criterion emanated from the case study research. Literature about collaboration between client and contractor is scarce. Nonetheless, collaboration was a key factor for success in three case studies where collaboration was applied intensively.

12. **Participation with stakeholders.** This criterion also emanated from the case study research. Participation has not yet been implemented in the current methods to execute SRM, but in five out of six case studies participation with stakeholders played a crucial role to execute the LIP.

Design criteria that emanated from the findings and issues about the research component complexity:

13. **Six practical complexities.** This criterion originated from the literature study. All complexities occurred in all case studies, but they clearly were found the theory about complexity. Nevertheless, the occurrence of all complexities in the cases proves that they should all be taken into account and used to categorize the issues.

14. **Prioritizing issues.** This criterion originated from the case study research. By categorizing issues in LIPs in the six complexities they can be solved faster by the corresponding manager and linking a complexity to an issue makes prioritizing easier. This could solve the issues and delays from the cases. Also one large issue can contain several complexities, creating sub issues which can be managed.

15. **Dynamic complexity.** This criterion originated from the literature study and case studies. According to the literature changes are inevitable due to the long lifespan and changing interests. This was confirmed in the case studies, where changes caused several issues which were hard to manage. Therefore dynamic complexity is taken into account, across the six other complexities.

Design criteria that emanated from the findings and issues about the research component integrated contracts:

16. **Sharing risks and responsibilities.** This emanated from the case studies. Sharing responsibilities was not found during the literature study, but from the case study researches it became clear that several SRM managers of clients and contractors shared responsibilities outside the contract. This has proven to be beneficial for the LIP, by engaging issues according the competency of the SRM manager.

17. **Competency to deal with issues.** This criterion originated also from the case study research. When both SRM managers of the client and contractor indicated in advance if they were competent or felt responsible to take on the risk, issues could be solved more easily in the cases. If both SRM manager are competent or feel responsible to tackle issues, they can be shared.

18. **Flexibility instead of strictness.** This criterion emanated from the literature study and case study research. Flexibility is stated as one of the intended added values of integrated contracts in the literature, but it became clear from several examples in the case studies that there is actually a lack of flexibility. The responsibility for issues can shift during the LIP and freedom in the contract could help.

What is the solution to improve the execution of SRM?

The design criteria which emanated from the findings in the literature study and case study researches led to the development of the solution tool, which is designed to contribute to this research to solve the problem statement (2.1). The tool consists out of three main components. At first a step-based plan for the execution of SRM as stated in the theoretical framework forms the base of the model. The steps are slightly changed compared to the original plan from the theoretical framework, to adjust them properly to the accompanied tasks of the solution tool.

The second component is used in order to quantify the responsibility division between client and contractor, which will eventually be stated in the third component: the responsibility grid. It consists of an ‘issue-complexity matrix’ and an ‘issue-competency matrix’ which should be filled out in consultation. Both client and
contractor should prioritize the alleged issues of a LIP by categorizing them in complexity types. Furthermore, the competency of the organization to tackle the categorized issues is scored in the ‘issue-competency matrix’. The third component is a quartered ‘responsibility grid’ with two axes (responsibility of the contractor and responsibility of the client) emanated from the first thought to solve the strict responsibility divisions. This grid should become the outcome of the tool, serving as an instrument to facilitate discussions between client and contractor. In this grid both client and contractor can visualize their responsibility for particular issues. Scoring issues with responsibility is done with the marks 0 to 10. These marks emanate from the two matrices which should be filled out in the second component. The issues can be placed in four quadrants: ‘contractor engagement’, ‘client engagement’, ‘collaborative engagement’ and ‘participative engagement’. This grid is applied in the step-based plan to determine the desired engagement.

How will the solution tool improve the current issues in executing SRM?

A feedback meeting was held by means of a workshop in which three groups of two participants applied the solution tool on a topical case project. At the end of this workshop the tool has been evaluated and possible improvements to adjust the tool were noted. The final ‘DRD-tool’ (Desired Responsibility Division tool), which is visualized in Figure 29, has been designed by applying the following adjustments on the solution tool:

- Switch the order of the ‘issue-complexity matrix’ and ‘issue-competency matrix’.
- State the sub-issues instead of numbers in the boxes of the ‘issue-complexity matrix’.
- Diagonal line through the quadrants in the grid to indicate who takes the lead with issues.
- Describe issues more detailed in advanced project phases to let more complexities arise.
- The model should be used to visualize the desired responsibility division instead of the actual division.
- Switch the colors of the collaborative and participative quadrants, red must indicate crucial issues.
- The link with contractual agreements should not be forgotten, although it is a separate matter.
- Naming the tool will contribute to a better understanding and can trigger managers to use it.

Figure 29: Final ‘DRD-tool’ and ‘DRD-grid’ (Heeringa, 2015)

An instruction manual for the use of the ‘DRD-tool’ should be used as a guideline to support SRM according the following steps: identify issues, prioritize issues, desired engagement, evaluation and adjustments/flexibility. Next to that, some important side notes are stated to improve the usability. Both client and contractor should keep in mind that the values will visualize the desired responsibility division outside the contract and should be filled in accordingly. It must be checked afterwards if the desired responsibility division is also possible within the contractual boundaries. Both client and contractor must fill out the values in consultation, otherwise managers strategically give low marks, while they are the most competent. Finally it should be noticed that the ‘DRD-tool’ is not the solution, but an instrument used as a tool to facilitate discussions about the issues.
7.1.1 ANSWERING THE MAIN RESEARCH QUESTION

All sub-questions have been discussed and therefore the main research question can be answered:

What contributes in solving issues with complexity and integrated contracts in Stakeholder Relationship Management during Large Infrastructure Projects?

During this research a tool has been developed to contribute in solving the current issues with complexity and integrated contracts in the execution of SRM. The tool is named ‘DRD-tool’ (Desired Responsibility Division tool) because it is important that it should be used to discuss the desired-, instead of contractual responsibility division between clients and contractors. This means that both managers should temporarily forget the contractual agreements about the responsibility division and fill out the components of the ‘DRD-tool’ according to the desired situation.

Several standard methods have been developed recently to structure SRM or support the tasks. A general structure which they have in common is a step-based plan. Increasing complexity and integrated contracts are seen as the main factors in causing issues for SRM. Detail- and dynamic complexity form the scientific structure and social-, technical-, organizational-, legal-, financial- and temporal complexity form the practical structure.

The introduction of integrated contracts has the consequence that the responsibility division between client and contractor is changing. Many responsibilities are shifted to private contractors who have to execute new tasks including SRM. The static character of integrated contracts leads to discussions between client and contractor about responsibility division.

The respondents acknowledged that a standard method for SRM would be beneficial. Collaboration and participation were recognized as key factors for success in the case studies. Main issues arose with contractual changes and misinterpretation of agreements. All issues that occurred contained one or more of the six practical complexity types, although not every complexity was equally important. Next to the six complexities of the practical structure, dynamic complexity was recognized in the cases. All respondents from both client and contractor felt that at this moment too many responsibilities are shifted to the market. Responsibilities were strictly divided in all cases, but in some cases SRM managers shared responsibilities outside the contract which resulted in beneficial solutions for the LIP. The main disadvantage as stated by all respondents in the case studies is the lack of flexibility in integrated contracts.

These issues can be solved by applying the ‘DRD-tool’ in the execution of SRM during LIPs, with some important side notes. Both client and contractor should keep in mind that the values will visualize the desired responsibility division outside the contract and should be filled in accordingly. It should be checked afterwards if the desired responsibility division is also possible within the contractual boundaries. If the desired situation does not fit in the actual contractual situation, this tool can be used to convince the contract managers to adjust the contract. The ‘DRD-tool’ is not developed as the solution for the issues, but should serve as a tool in the form of an instrument to facilitate discussions about the responsibility divisions.

7.1.2 DISCUSSION

The goal of this research was to understand the current issues on complexity and integrated contracts which influence SRM and eventually create a solution tool that contributes to the execution of SRM in LIPs. It became clear from the case study researches that the current methods for executing SRM are not used very much, but that the demand for a standard method is high. Also collaboration between client and contractor and participation with stakeholders were important in the case study researches to cope with the current issues. This collaboration and participation has not been implemented in the current developed methods which can be seen as a shortcoming. The six practical complexities and dynamic complexity which have been found in the literature all returned in the case studies and should become an important factor in prioritizing issues. The changes due to dynamic complexity were also present in the case study, mainly because of changing demands of clients and misunderstandings of agreements with stakeholders. It is visible in practice that the responsibility division in the current integrated contracts is strict and static.
Discussions and eventually claims were the result of the clear boundaries in responsibility division. Flexibility and more freedom in integrated contracts is seen by many respondents as a necessary improvement to implement in integrated contracts. In the current situation this flexibility is added outside the contract between the SRM managers themselves. Both managers are sharing responsibilities outside the contractual boundaries when they feel that they are the most competent to tackle an issue or feel that they can help the other manager. By using the solution tool this desired responsibility division can be openly be discussed and eventually should be embedded in the contract. Flexibility is also added by the solution tool when it is used in a regular manner, depending on the LIP and its current construction phase. In that way changes in the responsibility division can be addressed and discussions about new issues are started.

In the desired situation the ‘DRD-tool’ should be used to enhance the collaboration between client and contractor and create more participation with stakeholders. In that way the current issues due to changes and misunderstanding of agreements can be tackled earlier. If the client and contractor collaborate as one project organization and participates with the important stakeholders, the execution of SRM can be improved.

Furthermore, the ‘DRD-tool’ should trigger the SRM managers from both client and contractor to think outside the contractual boundaries and share responsibilities in the field of SRM if this is beneficial for the LIP. The current situation with the found issues and the desired situation with the intended improvements are visualized in Figure 30. Furthermore, the ‘DRD-tool’ is visualized as an arrow which should be should to get from the current to the desired situation. It is important to notice that the ‘DRD-tool’ should not be seen as the solution, but as a tool in the form of an instrument to facilitate discussions which contributes to solving issues in SRM. Eventually solving these issues should lead to the transition from the current situation to the desired situation as shown in Figure 30.

Figure 30: Current situation vs. desired situation (Heeringa, 2015)
7.2 RECOMMENDATIONS FOR FURTHER RESEARCH

In this research new insights in the theoretical and practical issues according complexity and integrated contracts in SRM during LIPs are given. The ‘DRD-tool’ should be used to contribute in solving issues with SRM and eventually to get from the current situation to the desired situation, where collaboration and participation are the main factors. This paragraph will discuss the possible directions for further research in this field or further expansions on important parts of this research.

Further development of the ‘DRD-tool’
Further development of the ‘DRD-tool’ can make it more applicable in practice, although it has been tested in practice by means of a workshop and several adjustments are already done. It is particularly important that further research should look into the link between the desired responsibility from the tool and the possibilities to implement this in the contractual agreements. This research has elaborated how the desired responsibility division can be established, but how this can be realized in real LIPs by means of changing the contract should be investigated.

Also a software program or excel plug in could be created to make the tool easier to use and digitalize the content. In this way the users do not have to fill out the matrices and grid manually every time the tool is used. This assures that the identification and making an inventory of the scores will speed up, which leaves more time for the actual goal of the tool: the discussion about issues with the ‘DRD-tool’ as an instrument. In that way the attention of both client and contractor is shifted more to the discussion.

Create awareness for collaboration and participation in SRM
Collaboration and participation, or actually the lack of it, have been noticed as the most important findings in the execution of SRM in practice. Collaboration has been identified by the respondents of the case studies as one of the most important factors for project success. In the cases where client and contractor collaborated intensively with each other and shared responsibilities, the execution of SRM has been recognized as very successful. Nevertheless the current methods do not hold much information about these aspects. Collaboration between client and contractor mainly occurs outside the contractual boundaries and depends on the personal relation between the SRM managers.

Participation with stakeholders is an activity in SRM which is mainly executed based on personal experience and initiative. Participation with stakeholders was seen by the respondents from five out of six case studies as inevitable to realize the LIP. Still not much literature was found about how to participate with stakeholders. Therefore more awareness in both fields could be created, to give collaboration and participation more prominent positions in the execution of SRM.

In depth research to add flexibility in integrated contracts
The literature about integrated contracts clearly stated that the more integrated a contract becomes, the more responsibilities are shifted to the private market. This causes that responsibilities are increasingly more divided between client and contractor. Intended freedom in design and execution is stated in theory as an important added value of integrated contracts. In practices the respondents actually experienced that the lack of flexibility is one of the main hurdles for the execution of SRM. Everything is framed and documented in the contract, which causes that changes cause complex issues. SRM managers share responsibilities outside the contract in the current situation, because it was seen as inevitable in solving several issues. Therefore, more research could be done to examine if more flexibility can be added to integrated contracts.
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APPENDIX A: ADDITIONAL ELABORATION ON THE LITERATURE

This appendix contains in depth researches about the definitions and structures of the three research components, which are used in the main report. At first a general definition for SRM will be created, with literature from several resources. Secondly the different working fields which are stated as the practical structure of SRM in the main report, will be further elaborated. Furthermore an explanation about complexity will be given and after that the different types of complexity as stated in the main report will be elaborated. In the end the different types of integrated contracts will be extensively elaborated.

THE DEFINITION OF SRM

This paragraph will elaborate several resources about SRM, to create a general definition which will be used in the main report. Literature from different research fields are researched to create an extensive definition.

At first it is important to clarify the definition of a stakeholder, because that is the central term where SRM is all about. A stakeholder can be defined as: “any person or organization that has legitimate interest in a project, who can affect or be affected by organizations with their managerial behaviors and by the product throughout the product’s life cycle” (Karim, Rahman, Berawi, & Jaapar, 2007, p. 2). Especially in LIPs there are many persons and organizations who are affected by the product. These projects are of such scale with so many involved stakeholders (all with different power and interest in the project) that they have major impacts on the surrounding environment.

After that it is important to explain stakeholder management, because this is the transition from stakeholder to SRM and the main working field within SRM. A general definition of stakeholder management is given in: ‘A Stakeholder Approach to Strategic Management’ by (Freeman & McVea, 2001, p. 22): “Stakeholder management is built on a partnering mentality that involves communicating, negotiating, contracting, managing relationships and motivating”. Freeman uses the general term ‘stakeholder management’. The definition uses communicating, negotiating and managing relationships with stakeholders, which are elements within the discipline SRM, but does not covers the whole discipline. The purpose of stakeholder management is to let managers form and implement processes, which are used to satisfy groups or persons which have a stake in a project. The central task in these processes is integrating the relationships and interests of all stakeholders, to ensure the long term success of a project. The described purpose is a good proof why the specific term stakeholder relationship management is chosen for this report (Freeman & McVea, 2001).

Another approach on stakeholder management is defined in ‘Management in Networks’ (ten Heuvelhof & de Bruijn, 2012) by describing networks and decision making processes. They do not give a particular definition of stakeholder management, but they focus on the management of the actor network. A network is explained as: “a number of actors with different goals and interests and different resources, who depend on each other for the realization of their goals” (ten Heuvelhof & de Bruijn, 2012, p. 1). The definition is based on the fact that everyone depends on each other, because without the support of stakeholders the implementation of policies or strategies becomes difficult. Networks can occur in both private- and public sector organizations and can be intra- or inter organizational. Governmental organizations consist of multiple departments with conflicting interests within and between themselves. Companies are also part of an external network and therefore depend on external actors. In addition, the increasing complexity of the tasks to be performed makes organizations dependent on highly skilled actors (ten Heuvelhof & de Bruijn, 2012).

One of the first approaches for executing SRM to solve problems of organizations with their environment is developed by Marc Wesselink. It is defined with the letters: SOM, representing the Dutch words: ‘Strategisch OmgevingsManagement’ (which means strategic SRM in English). Wesselink defines SRM as: “A combination between stakeholder management and issue management, where stakeholder management is traditionally arranged to serve the interests of an organization by minimizing risks which are caused by parties with other interests” (Wesselink, 2011, p. 2). Issue management is the search for new issues in a certain environment, where an issue is a development for which stakeholders can take a stand in favor or against. For an organization it is important to come to know which issues they will be confronted with. With SOM first issues are identified and after that stakeholders, to get a more complete image (Wesselink, 2011).
According to RWS, the executing organization of the ministry of infrastructure and environment, the term SRM entails: “All activities aimed at exploring and involving all surrounding parties, with the objective to identify and realize personal and shared goals and to keep control of execution of own stakeholder management” (Rijkswaterstaat, 2009, p. 15). RWS confirms that this is not necessarily the right name for what is called the relation with the world outside the construction project. Next to the overarching term SRM, several terms like public participation (EPA, 2015), public-oriented network management (Rijksoverheid, 2015) and interactive policy making (European Commission, 2015) are used to describe relations with stakeholders. The goal of the stakeholder relationship manager is to bring the environment inside the project and bring the project in contact with the environment the other way around. This could create mutual understanding between stakeholders and should ideally lead to solving problems in a participation society (Rijkswaterstaat, 2009).

Another description of an independent consultancy firm for stakeholder management implies SRM as: “a shift in the definition of the fiduciary duties of the management: from a mono-stakeholder perspective (where only the interest of the shareholders is to be taken into consideration) to a multi-stakeholder perspective, where all the corporate stakeholders are relevant to identify the management's fiduciary duties” (de Colle, 2005, p. 2).

This is based on the assumption that the organization should be managed by not only taking the stakes of stockholders into account, but look into various stakes of all possible stakeholder groups. The main problem in stakeholder theories is that managers are required to respect their fiduciary duties towards stockholders and stakeholders. This means that managers should maximize profits to satisfy stockholders, but they should abandon the profit oriented mindset to satisfy the stakeholders (de Colle, 2005).

The municipality of Amsterdam instructed to make a report about SRM, in which the following definition of the term is used: “Actively approaching, involving, researching and directing of the project environment, to enable and ease the realization of a project” (Haak & Wanningen, 2013, p. 12). Among other things, this can be achieved with finding similarities, communicating, eliminate negative effects and careful preparing. Everyone that has interest in the direct area of the project should be seen as the work field of SRM. The analysis of the project environment and finding the interests of stakeholders has become an important part of modern project management. The involvement of the environment ensures that surrounding stakeholders can provide input, which can lead to positive adjustments in the project. Preparation of the construction works is necessary to actually implement the project and meet the expectations. (Haak & Wanningen, 2013).

According to (Poorter, 2006, p. 10), independent researcher at the section Real Estate and Housing at the TU Delft, SRM is defined with the words ‘stakeholder participation’ in the field of real estate. Stakeholder participation occurs in the field of real estate when: “Housing associations involve other parties in decision making, particularly on policy fields, like municipalities, healthcare and welfare organizations, private parties and other associations.” Involvement of stakeholders goes beyond maintaining contacts with clients. The organization has to enter in dialogues with stakeholders to find out how they experience services of the organization. It is important that the term participation in this case concerns involvement of stakeholders, not full collaboration. The scale on which stakeholder participation is executed by real estate corporations is mainly on the project level, which are often of a smaller scale than LIPs, but the concept is the same (Poorter, 2006).

VolkerWessels is one of the largest contractors in the Netherlands and has to deal with SRM in LIPs more and more. Seen from the perspective of this private contractor, SRM entails: “The responsibility to bring the diversity of contradicting demands and wishes of stakeholders together with the preconditions of the contract” (Volkerinfra, 2015, p. 1). This definition differs from the previous definitions made by independent- and governmental organizations, but the main goal is still to align the contradicting interests of stakeholders. The projects of this organization cause large impacts on the direct work environment. Especially in LIPs many stakeholders are involved, which want to give their critical opinions. Therefore, limiting negative impacts on the environment and take the interests of stakeholders into account are of great importance to show the company’s social sympathy. The difference between SRM in traditional contracts compared to integrated contracts is that the contractor executes SRM activities as well. Just like RWS, the contractor has to communicate, manage stakeholders on technical- and social complex fields (VolkerWessels, 2010).
THE PRACTICAL STRUCTURE OF SRM

This paragraph elaborates the practical structure of SRM as an extension of the working fields as stated in the literature study (3) about SRM in the main report. The working fields are assembled by combining different resources from the private and public sector.

Stakeholder management

Stakeholder management is on purpose the first stated field of SRM, because this is the largest playing field of SRM were most issues occur. This is the search for common goals, compromises and compensating measures, together with surrounding stakeholders including public organizations. This also means the ensuring the acceptance of the project result (Haak & Wanningen, 2013). Stakeholder management focuses on people with interest in the area of a project. A process is used to execute stakeholder management.

At first, stakeholders with influence on the project and stakeholders on which the project has influence are mapped, together with their interests. Stakeholder management can deal with external as well as internal stakeholders. Furthermore, a stakeholder analysis is an indispensable tool for SRM managers to map the diverse stakeholders and their interests. Besides the mapping of all stakeholders with their power and interests in the area of a project, changes within these power and interest should be recognized. The stakeholder analysis forms the basis for the stakeholder strategy, which states how to engage the important stakeholders after the stakeholder analysis. Another tool for the SRM manager is a force field analysis, in which the stakeholders and their corresponding influences are stated (Rijkswaterstaat, 2009).

Communication

The field communication in SRM concerns not just the internal communication within the project organization, but also the communication with external stakeholders, the municipality and the press. The SRM manager has to develop a communication plan in which a strategy, actors, messages, milestones and agreements about the informing of stakeholders are stated. Usually the SRM manager is assisted by a communication advisor, who focuses especially on this working field of SRM. Every stakeholder has to be informed in a different and unique way and within time about the project and its process. Examples of tasks for communication are the handling of complaints, questions and other input from stakeholders (Haak & Wanningen, 2013).

Communication in SRM is called area communication by Van Hattum & Blankevoort (Bolle, 2008), which stands for the communication with the neighboring area of a construction project in terms of important stakeholders. It has the objective to create mutual understanding and support between the client/project organization and its different target groups. This is a communication type aimed at the external network. Area communication is about the mutual interaction between the project organization and surrounding stakeholders. The responsibility of area communication can be stated in the contract in three different ways. In the first way, the client is responsible for the area communication and the contractor is not allowed to communicate with external organizations. In the second option, the contractor is responsible for the area communication and the client watches from a distance. The last option is that the responsibilities according area communication are divided between the client and contractor (Bolle, 2008).

(Public) Participation

Surrounding stakeholders could get a bigger role in the design of a new LIP and the decision if a new LIP should be, or not be constructed. Decisions improve when surrounding stakeholders share their ideas and interests which should be taken into account in the choices of managers (EPA, 2015). Participation is therefore an important addition to the relationship between managers, officials and the public. The tasks for the SRM manager according participation are for example: balance out in which way participation can contribute to decision making, making a participation plan (who will be involved when and in which problem?), preparing and executing participation moments and justifying the results with the public. The goal of participation is to solve project issues, by enlarging the support. It is a misconception that opponents of the project plans are dominating the participation more than supporters (EPA, 2015).
(Stakeholder) participation plays a role in all phases of a LIP, because stakeholders can always cause issues. The SRM manager executes the participation process according legislation and personal experience. The given space to participate depends on the project phase, because it is crucial if the design is already fixed. A tool for (public) participation is the participation ladder, which visualizes how many influence stakeholders can exercise with a particular form of participation. With this tool the SRM manager can keep control on the influence which is given to stakeholders in every project phase. The steps of the ladder represent the influence of the public from little influence in the first step to coproducing in the fifth step (Rijkswaterstaat, 2009).

**Conditioning**

Conditioning is the working field of SRM which concerns making physical planning and juridical interference possible and makes sure that the building site is clear to execute the project. Several processes have to be prepared or completed before the actual execution of a project can start. Also during the execution of a LIP activities need to be done to ensure the continuation. Examples of conditioning activities are: obtaining permits, move piping and cables from third parties and physical planning conditioning (flora and fauna, environmental effects, unexploded explosives, archeology and land acquisition) (Haak & Wanningen, 2013).

Mapping the juridical and physical boundary conditions in a LIP and eliminating potential obstacles which result from these boundary conditions is called conditioning. In the planning phase of a LIP it is important to indicate the risks and involve surrounding stakeholders. During the design phase of a project it is necessary that the needed permits, exemptions, expropriations and more legal affairs are dealt with by the SRM manager. The task of the SRM manager is to create an obligatory juridical plan by interacting between governing bodies and the stakeholders. The SRM manager determines the strategy for approaching stakeholders and monitors the made agreements. Examples of tasks which the SRM manager has to execute in the field of conditioning are: Land acquisition, control planned damage and damage compensation, water management, preserve natural and cultural history and make legislative agreements (Rijkswaterstaat, 2009):

**Traffic management**

Traffic management is a discipline which plays a large role from the beginning of the planning phase in a LIP. In the planning phase the necessity of a new traffic connection is specified and a feasibility test must prove this. An excess of traffic demand should be compensated with so called demand deflection. Rijkwaterstaat has developed a method (ToeKan-methodology) to estimate to what extent the demand deflection can resolve the settlement problems. This is done in combination with actions in the field of traffic management, mobility management and communication management (Rijkswaterstaat, 2009).

Besides that, traffic management should test if the connection has enough resolution power. For example, if a new freeway is constructed to unburden an older freeway, but most of the traffic keeps using the old freeway the resolving power is not enough. It should be taken into account which other projects are executed during the execution of a LIP and what the consequences according to traffic load are during this execution. The task of the SRM manager is to bring the different demands and wishes from projects which are executed at the same time together. This can serve as input for the SRM manager’s own project, to adjust the demands and wishes of the project to align with the road owners and road users. The SRM manager collaborates with the traffic manager of the client, the road owners of the municipalities within the project scope, SRM managers from other projects and network administrators (Rijkswaterstaat, 2009).
EXPLANATION AND HISTORY OF COMPLEXITY

This paragraph will create a general definition of complexity and states the emergence of complexity in LIPs throughout history. This will be done by consulting different resources about complexity and combining the similarities in these resources. A summary will be given in the literature study (3) in the main report.

SCIENTIFIC DEFINITION OF COMPLEXITY

Several researches are conducted to state the definition of complexity. Nevertheless little literature has been published about complexity in construction projects. Although many resources describe complexity as very hard to define because it is a dynamic instead of static phenomenon (Verweij, 2015), different literature developed a theoretical perspective for project complexity. According the Collins English Dictionary the term complexity means: “the state or quality of being intricate or complex”, where complex is defined as “made up of many interconnecting parts” (Wood & Gidado, 2008, p. 6). The Oxford English Dictionary gives an almost similar definition for complexity: “consisting of many different and connected parts” and “not easy to understand, complicated or intricate” (Ochieng & Hughes, 2013, p. 1).

Construction projects are also made up out of interconnecting parts, but the construction process is one of the most risky and complex businesses to undertake and therefore the previously described broad definition is not extensive enough. Project complexity is therefore defined more extensively by Gidado as: “the measure of the difficulty of implementing a plan to achieve a number of quantifiable objectives” (Wood & Gidado, 2008, p. 6). Azim et al. has researched that construction project complexity is defined with a variety of explanations, which range from: “a variety of people in terms of skills and experience, to a multidisciplinary, multi-national, multi-site and a lot of stakeholders” (Ochieng & Hughes, 2013, p. 1). Combining these definitions gives the following general definition for project complexity: “the measure of the difficulty with a variety of interconnecting parts in terms of people, products and processes” (Heeringa, 2015). Although this definition will be used in the main report, it stays a dynamic phenomenon which develops and may change the definition in the future.

HISTORY OF COMPLEXITY

In ‘Towards a new model of complexity’ (Dunovic, Radukovic, & Skreb, 2014) the writers elaborate the background of project complexity, by describing the development of different perceptions and concepts about complexity throughout history. Their research on the perception and elements of complexity is part of a bigger research about LIPs.

Figure 31: The perception of complexity throughout the years (Dunovic, Radukovic, & Skreb, 2014), modified by (Heeringa, 2015)
Complexity originates from the basis of project management, this basis is elaborated as the ‘systematic approach’. Since the late 1950s, when complexity was experienced in LIPs, the perception of complexity has developed significant and it is still developing. Figure 31 shows this development of the perception of complexity throughout the years (Dunovic, Radujkovic, & Skreb, 2014).

Different schools of thought elaborated concepts for project complexity from different aspects. Baccarini formulated the first important concept with the thought that project complexity originates from ‘a lot of different independent parts’ (Baccarini, 1996). He states that this project complexity occurs in two types: organizational- and technical complexity. Williams further elaborates the concept of organizational- and technical complexity by distinguishing differentiation and interdependence in both complexity types (Williams, 2002). He states that these concepts are covered by one complexity type: structural complexity. Another type of complexity according to Williams is: uncertainty, because of ‘the instability of the assumptions upon which the activities are based’ (Williams, 2002). After that, Geraldi further expands the concepts of Baccarini and Williams by dividing complexity in three groups. ‘Complexity as faith’ occurs when something is unique and can be compared with uncertainty. ‘Complexity as fact’ can be compared with structural complexity and occurs when a large amount of information is related. ‘Complexity as interaction’ is added by Geraldi as another complexity and occurs because of the interaction between people and location (Geraldi, 2008). The concept of Remmington and Pollack is even more detailed and they distinguish four types of complexity. Structural- and technical complexity are similar to the concept of Williams. Temporal complexity can be related to variability and is compared with the ‘complexity as interaction’ concept of Geraldi. Directional complexity is added as a new type which appears when there are unknown objectives (Remington & Pollack, 2007). Table 6 is an overview of the development of the different concepts of project complexity. The last important research on project complexity is done by Hertogh & Westerveld, who ‘played with complexity’ to combine the different schools of thought with practical examples in LIPs (Hertogh & Westerveld, 2009).

Table 6: Types of complexity from different schools of thought (Dunovic, Radujkovic, & Skreb, 2014), modified by (Heeringa, 2015)

<table>
<thead>
<tr>
<th>School of thought</th>
<th>Complexity type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baccarini</td>
<td>Structural technical</td>
</tr>
<tr>
<td></td>
<td>Structural organizational</td>
</tr>
<tr>
<td>Williams</td>
<td>Structural</td>
</tr>
<tr>
<td></td>
<td>Uncertainty</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
</tr>
<tr>
<td>Geraldi</td>
<td>Factual</td>
</tr>
<tr>
<td></td>
<td>Faith</td>
</tr>
<tr>
<td>Remmington &amp; Pollack</td>
<td>Structural</td>
</tr>
<tr>
<td></td>
<td>Technical</td>
</tr>
<tr>
<td></td>
<td>Temporal</td>
</tr>
<tr>
<td></td>
<td>Directional</td>
</tr>
<tr>
<td>Senge</td>
<td>Detailed</td>
</tr>
<tr>
<td></td>
<td>Dynamic</td>
</tr>
</tbody>
</table>

Hertogh and Westerveld found that the scientific view on complexity can be divided in two perspectives: detail- and dynamic complexity (Hertogh & Westerveld, 2009, p. 182). Although project complexity has been defined in a scientific way, several practitioners state that complexity in practice is different. In the practical point of view, complexity is explained by practitioners as: “A project has extremely diverse characteristics, technology (innovation), contractors, politicians and other stakeholders play a very important role. That makes every project unique.” (Hertogh & Westerveld, 2009, p. 136). The practical experiences of managers from LIPs demonstrate that complexity is a concept which illustrates the challenges that have to be managed during the execution of LIPs. Taken the different schools of thought and experiences of practitioners into account, six complexities in the practical point of view are distinguished by Hertogh and Westerveld: technical-, social-, financial-, legal-, organizational- and time complexity (Hertogh & Westerveld, 2009, p. 137). Table 7 shows a matrix in which all types of practical- and scientific complexity are stated and how they are connected. For example, ‘large number of interested parties’ is a social-, but also detailed complexity and ‘conflict of interest’ is a social-, but also dynamic complexity.

The ‘HM Treasury’ and ‘Infrastructure Client Group’ from the United Kingdom have recently created the ‘Delivery Environment Complexity Assessment’ (DECA) tool (HM Treasury, 2014). The goal of the tool is to show the value of effective collaboration between government and industry to improve the delivery of LIPs. The practical use of the tool is addressing complexity of a LIP. The tool provides twelve factors which are key influences for success or failure of a project. The purpose is to launch a discussion around the impact of the twelve factors to assess challenges in implementing LIPs. Stakeholders can decide whether the potential impact of the factors is high, medium or low to create a general view on the complexity of a LIP (HM Treasury, 2014).
Taken all researches about the definition and explanation of complexity into account, it can be said that the scientific definition of complexity is: “the measure of the difficulty with a variety of interconnecting parts in terms of people, products and processes” (Heeringa, 2015). This scientific view can be divided in detailed- and dynamic complexity according Hertogh and Westerveld (Hertogh & Westerveld, 2009). Next to that, practitioners state that complexity in practice is different and harder to define. In the practical point of view, complexity is explained by practitioners as: “A project has extremely diverse characteristics, technology (innovation), contractors, politicians and other stakeholders play a very important role. That makes every project unique.” (Hertogh & Westerveld, 2009, p. 136). Therefore, complexity is divided in a scientific- and practical structure, which will be used as the concept of complexity for the rest of this research.

### STRUCTURE OF COMPLEXITY

This paragraph will elaborate the different types of complexity, as stated in the main report. A summary of these extensive descriptions is given in the main report in the literature study (3) about complexity.

#### Detail complexity

Detail complexity can be referred to as a system with many elements which have a lot interrelations. In this research the systems are LIPs and the elements are stakeholders, civil works, environment and so on. More interrelations between the elements does not always mean a higher complexity. Sometimes it depends on the length, strength or nature of the interrelations between the elements in a system. Detail complexity can be divided in three sub-systems:

- Stakeholders
- Product (Infrastructure facility)
- Activities

The high number of different stakeholders and their mutual relationships in a LIP shows the detail complexity of the first sub-system: stakeholders. Also the product, in the case of a LIP the infrastructure facility, consists of many different elements which have to be connected to each other. In the last sub-system, the activities in a LIP, detail complexity can be found in the performed tasks by the project organization and other stakeholders. The sub-contracts and permits which have to be dealt with influence each other and managing these procedures is one of the key tasks of the project organization. Although detail complexity always occurred in LIPs, it does not play a major role in crucial events. The expression ‘the devil is in the details’ is still applicable in current LIPs, maybe even more than ever before. Still LIPs have to cope with increasingly more changes in multiple businesses nowadays, that dynamic complexity has become even more crucial (Senge, 1990).
Hertogh and Westerveld support this opinion, because detail complexity has minor effect on the stakeholder arena. For example, the huge amount of stakeholders and their relationships with each other are not a key problem in a LIP, but when these relationships become unknown and unstable it causes problems. Therefore, more focus will be laid on the next perspective: dynamic complexity. This does not mean that detail complexity in a LIP should not be managed, it is only less influential in crucial events (Hertogh & Westerveld, 2009).

**Dynamic complexity**

The execution of a LIP is a challenging activity, because they have to be implemented in dynamic socio-physical environments. Unforeseen events are a certainty which always have impact on the environments in which LIPs are executed. Management plans are made to cope with the dynamic context with the expectations of managers based on their daily activities. Nonetheless, these systematic activities cannot prevent unforeseen activities to happen. If something is unforeseen or expected depends on the manager who has to deal with the event. Unforeseen events can be divided in two categories: the ones which arise from physical sources and the ones that arise from social sources. The unforeseen events from social sources are all unique and therefore all need specific managerial responses (Verweij, 2015).

The following two characteristics can be linked to dynamic complexity:

- The potential to evolve over time: self organization and co-evolution
- Limited understanding and predictability

The first characteristic comes from a systematic point of view: dynamically complex events have the potential to evolve over time, they are self organizing and are characterized by co-evolution. This can be linked to the stakeholders systems of a LIP, which are also unforeseen changing complexities. The second characteristic originates from a decision maker’s point of view, because they have to deal with the limited understanding and predictability of decisions in LIPs. This characteristic is related to uncertainty (Hertogh & Westerveld, 2009).

According the first characteristic of dynamic complexity, the potential to evolve over time is caused by stakeholder systems in a LIP. Several changes in these stakeholder systems can occur which cause the dynamic complexity. These changes can be categorized in different views. For example, ‘sensitivity of minimal changes in initial conditions - historical path dependency’ is a viewpoint in which the importance of the starting conditions come forward. A minimal change in these conditions cause major implications because of chaotic behavior of stakeholders. Another example of a view on changes in stakeholder systems is ‘Shifting preferences of stakeholders which trigger changes in the stakeholder system often originate from dissatisfaction’. The shifting in the preference of stakeholders is caused by changes in events, which leads to stakeholders acting or deciding differently than before (Hertogh & Westerveld, 2009).

According the second characteristic of dynamic complexity, the limited understanding and predictability is caused by uncertainty in decision making. This characteristic can be categorized in two different views of changes. The first view is ‘A causes B rationality is diffuse, there is skepticism about long range planning’, which means that the traditional A causes B assumes that affecting each other has a logical causality. Nonetheless, there are many hidden causalities which are not logical and therefore cause unforeseen changes (Senge, 1990). The second view is ‘Uncertainty on decisions and bounded rationality’, which implies that important decisions have to be taken while the impact of the change is not understandable or predictable. This implies the key difficulty of managing complexity in LIPs (Hertogh & Westerveld, 2009).

**Technical complexity**

The technical complexity in a LIP can be best described according two main issues:

- Unproven technology
- Technical uncertainty

Unproven technology is the extent to which a technology is innovative. Specific dimensions of the technology determine the level of innovation of technology, like: provability, robustness, coupling, divisibility and functionality (Hertogh & Westerveld, 2009).
According practitioners and several analyses the main technical complexity is unproven technology. New technologies hold many difficulties. The demands of a problem in a LIP are often unclear, which makes it difficult to know if the technology is suitable for the problem. New technologies also often cause the project to run over budget and time, which is against the project constraints. This causes discussions between stakeholders about the extra costs. Nevertheless is innovation necessary in LIPs, because the long duration and large scale of LIPs makes it possible to generate R&D developments. It can also be financially attractive, because a new innovation may save time and therefore money. On the other hand it is possible that new technologies cause risks and activate other complexities (Hertogh & Westerveld, 2009).

The second issue in technical complexity is technical uncertainty and can be described as the difficult choice for a technology, which is heavily influenced by the particular conditions were it has to be implemented. Especially in LIPs there are a lot uncertainties according the geology, because these projects are often executed in special conditions. Unknown conditions on the construction site make even the application of proven technologies a challenge (Williams, 2002).

Social complexity
Discussions about interests and demands of stakeholders and dealing with them, is the most important issue according to complexity in LIPs. Everything comes down to the social elements of dealing with stakeholders, which is therefore more important than technical, organizational, financial, legal and time complexities. All schools of thought hold this complexity since the start of exploring project complexity (Dunovic, Radujkovic, & Skreb, 2014). Social complexity is not only the most prominent factor in dealing with the many stakeholders around the project. Social complexity also seems to be the most prominent factor in the relationship with stakeholders within the project organization. It often occurs that the views of the contractor are in the same direction as the stakeholders outside the project, while the views between the contractor and the client within the organization are opposing each other. There is an explanation for the social complexity in LIPs, namely that there are too many different working fields in which the project organization has different roles. An additional explanation is that the client of a LIP often has responsibilities in a highly dynamic context (Verweij, 2015).

The overall finding of social complexity according to Hertogh and Westerveld is: “Social complexity in LIPs originates from conflicts of interest between the involved stakeholders that lead to different perceptions (opinions) and attitudes, on issues that have a large impact on their business, life or environment. Managing these conflicts of interest emerges as a core theme in the management of complexity in LIPs” (Hertogh & Westerveld, 2009, p. 152). It is important to notice that the conflict about interests and size of the impact is more important than the quantity of the stakeholders. Social complexity in a LIP can be linked with three elements which often occur during the execution:

- Conflicts of interest
- Different meanings
- Perceptions and large impact

Conflicts of interest arise when many stakeholders are involved, because with that many interests are at risk. The interests of stakeholders are often not aligned, which causes discussions and stakeholders trying to influence the project with their power. The driven force to execute the power they have to influence the project comes from self-interest. Another element of social complexity, different meanings and perceptions, means that different stakeholders have a different meaning of a LIP. The engineers working on a LIP feel good about the technological developments they make, while the surrounding residents are afraid that their environment will be damaged. The perception and meaning of a stakeholder is based on sense and can therefore change during a LIP. This process is called dynamic meaning. The last element of social complexity, large impact, means that a LIP has a lot impact on the environment, because they are constructed through large areas of land and important locations. The LIPs have a large influence on the future developments of the surrounding area (Hertogh & Westerveld, 2009).

Financial complexity
The financial complexity of a LIP is related to the Net Present Value (NPV), cost calculations and the financing of the project. This type of complexity is added by Hertogh and Westerveld compared to the complexities found in the different schools of thought and became very important since the introduction of DBFM(O) contracts.
Financial complexity is divided in five elements:

- Costs and benefits
- Perception of cost developments
- Different perceptions on definitions and agreements
- Strategic misinterpretation, optimistic biasing and pessimistic biasing
- ‘Cascade of distortion’

Cost and benefits are often not equally divided, because it is hard to quantify these parameters. Because a LIP is unique it is hard to estimate the costs within the scope. Also scope changes cause difficulties in the calculations according to dynamic complexity. It is also hard to quantify the benefits, because it depends on the meaning of stakeholders whether they think they benefit from the project. Furthermore, the perception of cost developments can greatly differ from the expected calculations. Cost overruns are the result of these miscalculations, because scope changes occur during LIPs. Another element is the different perceptions on definitions and agreements, which means that defined amounts often are misleading because they have a different meaning. One total amount is defined and agreed upon, while there is no discussion about the details. Another element of financial complexity are three factors caused by uncertainties in the scope. Two personal factors are important: optimism bias strategic misinterpretation. Optimism bias is caused by people who estimate possible events in the future in a more positive way. Strategic misinterpretation is the strategically underestimating of costs and overestimating of benefits to make sure that the project will be funded. The third factor is pessimism bias, which occurs when only the direct effects of a project are taken into account. The last element of financial complexity is ‘Cascade of distortion’, which means that distortion occurs when a report goes through several managerial layers before it reaches the recipient (Hertogh & Westerveld, 2009).

Legal complexity
The legal complexity in a LIP is based on the Dutch construction legislation and is also added by Hertogh and Westerveld compared to the complexities from the different school of thought. The Netherlands is a very densely populated country with many stakeholders who struggle to determine how to fill in the scarce areas which are left open. Therefore, a strict legislation by the government is necessary in order to keep control (Aedes, 2013). The following issues characterize legal complexity:

- Changing and conflicting laws
- Extensive legislation and rules
- People involved need space to operate

The complexity of changing-, not existing- and conflicting laws is that several procedures have different ways of executing. Building permits can have different procedures than environmental permits or they are not conform changed legislation. Also internal legislation in an organization can conflict with the perceived behavior in a LIP. Another issue of legislation in a LIP is that it becomes extensive. Every process in the lifecycle of a LIP has to cope with rules and legislation. In the Netherlands there is a very extensive legislation for line infrastructure (Route decision law), which covers the procedures of obtaining permits. The last issue of legislation in a LIP is that the involved people need space to operate. Sometimes project managers can speed up the process by executing processes not exactly according the rules. There are so many rules in the Netherlands, that it can be better to ignore the legislation in favor of the project (Hertogh & Westerveld, 2009).

Organizational complexity
The project organization of a LIP has to deal with all mentioned complexities. It is necessary that the project organization of a LIP has variety and complexity as well, because that is the only way to deal with the complex challenges of the environment. Organizational complexity is not only used for the structuring of the internal project team, but most importantly to divide the responsibilities and positioning of the project team towards the client (Williams, 2002). There are four described issues that divide organizational complexity:

- Find and keep people motivated appropriate to the challenge
- A lot decisions with no clear ‘best solution’
- Numerous interfacing processes within the project organization
- Numerous contracts with contractors, consultants and suppliers have to be arranged
The first issue of organizational complexity is to keep the people in a project motivated in an appropriate way to cope with the challenges. It is difficult to find appropriate personnel for the temporary tasks in a LIP and keep the key people for the tasks during the whole lifecycle. The second issue of organizational complexity is that sometimes decisions have to be made while there is no best solution available. Project managers have to live with the uncertainties and risks which some decisions entail. The third issue of organizational complexity are the numerous interfacing processes within the project organization. Every process within the organization has room for improvements, which makes it complex to structure. The last issue of organizational complexity are the numerous contracts with contractors, consultants and suppliers which have to be arranged. Integrated contracts were intended to reduce the amount of agreements, but those contracts bring other issues (Hertogh & Westerveld, 2009).

Time complexity
Time complexity is related to the other five named complexities because it arises from them. The long term impact of a LIP on the environment is an important factor of time complexity. There are two main issues showing time complexity in LIPs (Hertogh & Westerveld, 2009):
- Long time frames with ongoing developments
- No consecutive process of implementation

The first problem according to time complexity is that the execution of a LIP takes many years and in that time the society around the project changes. People come and go, new technologies are discovered, etcetera. Also within the project organization positions of people will shift. Flexibility has to be built into a static LIP within a dynamic environment to meet the changing expectations. The second issue of time complexity is that there is no consecutive process of implementation during a LIP. There are a large number of parallel processes, which is necessary, because otherwise the project would take hundreds of years. The planning of a LIP continuously has to be adapted to the current situation. During the approach of a process non-linearity occurs, which means that the manager’s viewpoint on the technology changes (Remington & Pollack, 2007).

The relative importance of the six complexity types
According many managers who worked on a LIP, all six complexities are present during the project. The difference is that not every complexity occurs equally often and significant. Social complexity occurs most often in every project, while legal and time complexity occurs much less often (Hertogh & Westerveld, 2009). Technical-, organizational- and financial complexity are also important, but not as much as social complexity. This confirms the earlier statement that social complexity is the most dominant complexity in LIPs. Technical-, organizational-, financial-, and legal complexity serve more as input for social complexity. Time complexity turns out to be an independent factor which shows the practical effects of change in a project. Not only the internal project organization recognizes social complexity as the most dominant complexity, but also for the external stakeholders social complexity is the most important during a LIP. The fact that social complexity and also organizational complexity are often seen as the most complex, is caused by their sensibility for change over time (Hertogh & Westerveld, 2009).
DIFFERENT TYPES OF INTEGRATED CONTRACTS

In this paragraph the different types of integrated contracts, as stated in the literature study (3) in the main report, are more extensively elaborated. The most important contract types are elaborated in a specific sequence: from the traditional ‘specifications’ (Bestek in Dutch) contracts to the highly integrated ‘general contracting’ contracts.

Traditional specification contracts (Bestek in Dutch)
These are contracts in which a public authority hires a private company to provide an execution task or a service for a certain period. The client is responsible for all construction phases until the building phase. One or more contractors can be hired in the whole project. The responsibilities and agreements are strictly divided for the design and the construction. An advantage of specification contracts is that they are a relatively low risk option, because the services are clearly defined in the contract. The contracts also are mostly conducted in a short period, which creates continuous competition in the sector (Asian Development Bank, 2007).

Rationalization and Automation in civil Works contracts (RAW in Dutch)
This contract type is more like a standard methodology to write down the demand specification. The RAW-methodology is the most frequently used traditional contract type. Also a clear division between design and execution can be made in these contracts. Although this contract type sounds like a standardized form of specification contracts, there are differences. For example, the contractor has the possibility to expand its tender by adding potential advantages of their execution plan for the design. This creates some more integration compared to specification contracts (Conducto, 2015).

Turnkey contracts
In a turnkey contract the contractor is responsible for the design and execution of a project. The client still has the initiation role and checks the feasibility, but besides that the client will be present again until he physically has to ‘turn the key’ of the project for deployment. These contract types are not only used in LIPs, but can also be used in other sectors like the IT sector (Conducto, 2015).

Design & Construct contracts (D&C)
In D&C contracts the integration of construction activities goes a little further than in turnkey contracts. One contractor is responsible for the general design, final design, preparation and execution of a project. Both client and contractor have one main point of contact and there is only one contract for the whole project (from the design until the construction phase). The client has to make a clear program of requirements with the demands and wishes for the whole project. During the execution the client only has a monitoring role. This monitoring role is less strict compared to traditional contracts, to give the contractor more freedom (Conducto, 2015). An E&C contract is a variant to the D&C contracts, in this case the design is already fixed by the client. The contractor still has the responsibility for the engineering of the design (Bouwlogie, 2015).

Design, Build and Maintenance contracts (DBM)
The DBM contracts are actually an addition to the D&C contracts. A maintenance component of a number of years will be added to the contractual agreements of the D&C contract. The contractor is therefore responsible for the design, construction and maintenance of a project. This leads to even more integration between the construction phases. When a contractor has to maintain a project they try to be innovative in the design- and construction methods, because they have to maintain it themselves. This improves the overall quality of the project (Bouwlogie, 2015).

Design, Build, Finance, Maintenance (Operate) contracts (DBFM(O))
Next to the previously stated responsibilities for the contractor to design, construct and maintain a project, a finance- and even an operation component can be added. These DBFM(O) contracts ensure that the contractor has to provide the financing of the project themselves, mostly through external financing organizations. In this case a division is made between ‘financing in advance’ and ‘financing from revenues’ (Conducto, 2015).
As stated before, DBFM(O) contracts are exceptional integrated contract types. The financial component plays a very important role in these contracts. This is because the client does not have to pay the initial investment of a project at once, but it is spread out over the different building phases. In general, a bank functions as a financer for the contractor. This means that the contractor not only has to deliver for the client, but also for the bank. If the project is not finished on the deadline the client does not give the agreed contract sum, which leads to banks that ask interest on the loan. Another important aspect of DBFM(O) contracts is flexibility. Because the contractors have to finance the projects by themselves, a long term period is needed to earn back the investments. Therefore, these contract types generally last 20 to 30 years including all design, build, finance and maintenance activities. During such long periods changes are inevitable and therefore flexibility is necessary. The current DBFM(O) projects are relatively new and therefore possibilities to add flexibility are researched by several organizations, like RWS and is seen as one of the main challenges of DBFM(O) contracts (Rijksgebouwendienst, 2009).

**Build-Operate-Transfer and similar contracts**
A private organization gets a contract for a certain period to develop, finance, manage and exploit a project. The build component consists of designing and building. The operate component entails the management and exploitation of the project for a certain period. The transfer component entails that the project is transferred to the client at the end of a time period. The client takes over the exploitation of the project if it is proven that the project functions well. When the private company invests in the project they own the service for a period set in the contract. A strength of BOT contracts is that they attract private investments and financial risks are reduced because the government is the only customer (Asian Development Bank, 2007, pp. 27-42).

**Alliance contracts**
In a Dutch alliance the client and contractor act jointly during the design and execution phases of a LIP. They come forward as one organization, they sit together in the same construction cabin and they have a joint cash jar for unforeseen risks. Optimizations and opportunities are researched together during the project and risks are shared. Knowledge of both sides can be bundles to complement each other. This should lead to the realization of cost reductions and time savings (Conducto, 2015). This contract type is not really embedded in the Dutch construction industry yet, but clients and contractors acknowledge the fact that more participation is necessary to make sure that LIPs not fail in the future. An example of this necessity is given in the construction journal Cobouw, in which an article about an alliance for the project ‘Zuidasdock’ is stated as the most applicable contract, due to the risks stated by professor Hennes de Ridder (Wassenaer, 2015).

**General Contracting contracts (GC)**
General contracting is the most integrated form of contracting. In this case the contractor takes over all tasks of the client, from coordination to plan studies and from design to execution, without responsibility sharing. The initial client only observes from a distance, although he can open the contract negotiations when necessary. A general contractor chooses its own sub-contractors, generally with traditional contract types per phase. This actually leads to traditional contracting, with the main contractor as a client. In the Netherlands these contract types are not often used for LIPs (Conducto, 2015).
APPENDIX B: FURTHER RESEARCH ON PPPS

This appendix is a separate in-depth research on Public-Private Partnerships (PPPs). A general definition of PPPs is created by looking at different resources. Furthermore, the reason why PPPs are used and the way in which they are tendered is explained. This background information creates a better view on the context in which the third component of this report, integrated contracts, appear.

DEFINITION OF PPPS

The ‘Public-Private Partnership Handbook’ (Asian Development Bank, 2007, p. 1) defines a PPP as “A range of possible relationships among public and private entities in the context of infrastructure and other services”, which is a really broad perspective. This type of activity is often also mentioned by the terms Private Sector Participation (PSP) and privatization, but actually they have a different meaning. A PPP is used as a framework for structuring the role of the government while engaging the private sector to ensure that social commitments and public investments are in good hands (Asian Development Bank, 2007, p. 5). In a PPP the tasks, agreements and risks between the public and private partners are stated. The public actor is a government organization like municipalities, ministries, provinces or state-owned companies. Public parties can play an assertive role in permit requests or make capital investments, while private parties have their expertise in commerce, operation and innovation. In some contract forms the private partner can also invest capital (Asian Development Bank, 2007, p. 1).

A section of the ministry of finance: Kenniscentrum PPS (Janssen, 2001) defines a PPP as “A government authority and the private industry working together on the realization of investment projects”. This can be infrastructure projects, but also the construction of a business complex or hospital. Social- as well as commercial goals can be realized with a PPP. A PPP contract defines the tasks and risks for both parties, which keeps the responsibilities divided. The goal of the partnership is to create added value, gain efficiency and stimulate innovation. The advantage for the government is that a project can gain quality when a private partner is consulted in an early stadium. A private partner can also add own capital investment to execute the project. An advantage for the private partner can be that they have influence on the project at an earlier stage. A LIP takes a lot of time to design, build and operate and therefore a long preparation time is needed. To align all features of the contract the governmental agency should consult the private market at a much earlier stage. This should prevent fruitless efforts from both parties and creates negotiations about possible solutions. Also a better analysis of risks and division of risk sharing can be made when both parties are involved from the start (Janssen, 2001). Pitfalls of early involvement of the private market can be that unequal competition is created, which is prohibited by the European procurement directives. Also a withdrawal from the negotiations after much preparation has already been done by a private partner can lead to claims. According to the European guidelines tendering procedures by the government are obligatory to prevent unequal competition in the free market (Janssen, 2001, pp. 2-4).

In ‘Handleiding PPS en aanbesteden’ (Janssen, 2001) a distinction is made between facilitation PPP and participation PPP. In a facilitation PPP the government only makes use of its administrative instruments to facilitate the project. The only collaboration between the public and private partners is the contractual arrangement. The actual development of the project with the corresponding tasks and risks are the responsibility of the private partner, the public partner has no financial risks. In a participation PPP the government has financial interest in the project. Within participation PPPs there are two forms: joint ventures and concessions. In joint ventures both partners share the risks and profits resulting from the exploitation of a project. In a concession the governmental agency puts the exploitation rights on the market for a fixed price.

The ministry of infrastructure and environment (Rijksoverheid, 2015) refers to a PPP as “A long lasting partnership between the state and companies to create projects for government housing and infrastructure”. The goal of this partnership is to create qualitatively better projects for which tasks and risks are divided. When the ministry of infrastructure and environment in the Netherlands refers to PPPs, the relatively new integrated contract type DBFM(O) is meant. Those are exceptional integrated contract types which are elaborated in the literature about integrated contracts (3.3) together with the other contract types. Not every project for government housing or infrastructure is suitable for a DBFM(O) contract.
The project must be of such large investment size that it is profitable and both risks and responsibilities must be bearable for both partners (Rijksoverheid, 2015). The advantages should outweigh the disadvantages of the project outcome. LIPs are carried out with a PPP if the project costs are above €60 Million. The contract with the private partner lasts throughout the whole lifecycle of the project, which can reach up to 30 years (Rijksoverheid, 2015). Despite this view of the Dutch central government, this research assumes that other integrated contracts can also be used for PPPs. Regional governments can also enter into PPPs, not necessarily including the finance component (Rijksegbouwendienst, 2009). It is therefore necessary to look into different definitions about integrated contracts in the structure of integrated contracts in the following section.

Every partner is responsible for the tasks and risks which they can handle best. PPPs (in this case DBFM(O) contracts) differ from traditional tendered projects in several ways:

- In PPPs the design, build, finance and maintenance phases are outsourced to a contractor, ensuring integrated solutions. In traditional contracts every project phase is outsourced to other contractors.
- A fixed project budget ensures that the client pays when the service which is agreed on, is delivered.
- The contractor bears the costs of the project, which is paid back in agreed periods.
- Procedures in PPPs tenders are more time consuming than in traditional tenders, therefore PPPs are more suitable for projects with a large investment size, opposed to small projects.
- If the contractor does not meet the agreed performance, the government can withhold parts of the agreed price.

The government states beneficial characteristics of DBFM(O) contracts above traditional contracts:

- The contractor can adjust every project phase on each other because they execute the whole lifecycle and are responsible for the financing, which makes it possible to reduce the total costs of a LIP.
- In DBFM(O) contracts the contractor is responsible for its own mistakes and failures and will therefore adjust the activities to each other, instead of leaving mistakes behind for the next contractor.
- Both contractor and client have equal interest in the succeeding of the project, because the contractor is paid according to the delivered performance, which makes it less tempting to mess it up.
- Clients outsource LIPs, which creates more time for core government tasks (Rijkswaterstaat, 2015)

A PPP is one tool for decision makers to reform LIPs and deliver services. Successful PPPs are designed together with other aspects, like attention to the context of the environment in which the PPP is designed. Several reform objectives can contribute to a better PPP contract. The policy environment, legal frameworks, financing requirements and stakeholder concerns are such objectives to take into account. In those objectives SRM plays a very important role (Asian Development Bank, 2007, p. 11).

As stated before, the term PPP does not have a clear definition and is therefore used as an ‘all-purpose word’ (containerbegrip). The term PPP is also used for governmental housing projects with an integrated contract, even though there is no real public-private collaboration, because the public and private responsibilities are strictly divided. To avoid confusion, the term integrated contracts is used in the main report when governmental housing projects and LIPs with such contracts are discussed (Rijksegbouwendienst, 2009).

General definition of PPPs

Several viewpoints from within the infrastructure field have been studied. Out of all definitions, the following definition is used for the rest of this report: “a long lasting partnership between a government authority and the private market to collaborate on constructing LIPs through integrated contracts, which are procured” (Heeringa, 2015). A government authority gives a problem definition (Rijksoverheid, 2015). During a tendering process several private organizations can hand in their solution, where the best solution is awarded with an integrated contract for the whole lifecycle of a project (Janssen, 2001). The common goal of a PPP is to implement a project with higher quality and a better division of risks and responsibilities compared to executing the project as a government entity alone (HM Treasury, 2012). In the Netherlands D&C and DBFM(O) integrated contracts are the most applied contracts.
TENDERING PROCEDURES IN PPPS

Some extra attention is devoted to the tendering of PPPs, in particular D&C and DBFM(O) contracts, because it is very relevant for the case study researches in this report. As stated before in the literature study about integrated contracts (3.3), DBFM(O) contracts can be seen as a service during the life cycle of a LIP, provided by a contractor. Not only the construction or maintenance phase is being tendered, but also the design, financing and sometimes operation of a LIP. A private organization offers the service to provide a facility, which they design, build, finance and maintain themselves. Generally, a governmental organization pays a reimbursement in terms of one sum, or in terms of revenue related reimbursements. The tendering goes according the European guidelines for ‘works’, which makes it possible for the governmental organization to choose between the public procedure and non-public procedure. Only in exceptional circumstances the client can choose for the more flexible negotiation procedure. Because it is hard to set the price for a complex DBFM(O) project, the negotiation procedure is best applicable for these PPPs, but the outdated European guidelines make it hard to make an exception for every LIP with a DBFM(O) contract (PPS Netwerk, 2015, p. 17).

Procurement for integrated contracts goes according to the three European procurement directives: the delivery directive, service directive and works directive (Janssen, 2001). The principle of these procurement directives is that government contracts are tendered in a competitive dialogue, to ensure an equal playing field. A potential project for integrated contracting starts with a competitive dialogue where a solution for a problem is formed by different participants. A governmental authority elaborates a detailed demand specification, which ensures the private contractor to offer a design which can be compared with offers of competitors. In PPPs the governmental authority wants to give the private market space to come up with an efficient and innovative plan, resulting from knowledge and experiences (Janssen, 2001). The competitive dialogue is created by inviting several private contractors to participate in the procurement. Competitive dialogues should answer a question to which no fixed solution has been found. Based on the private solutions, the government eventually picks the most efficient solution and the private organizations can make an offer to execute the project (Rijksoverheid, 2015).

INTERNATIONAL VIEWPOINT ON PPPS

The construction industry of the United Kingdom has a leading position in the modernization of the delivery of public infrastructure services. In the report ‘A new approach to public private partnerships’ (HM Treasury, 2012) the ministry of finance of the United Kingdom (HM Treasury) explains the advantages and downsides of Private Finance Initiative (PFI), the most frequently used form of PPPs in the United Kingdom. Also a fundamental reformation of PFI by the government has led to a new approach: PF2. Since 1992 PFI contracts were introduced to involve the commercial expertise and management skills of the private sector in improve the deliveries of public LIPs. The objective of the PFI contracts is to deliver high quality assets and better value for money for public services and infrastructure. The government wants to achieve this by transferring several risks to the private sector, controlling the total life cycle costs and innovative approaches for service deliveries. Just as earlier mentioned in the general definition of PPPs, the difference of PFI contracts compared to conventional contracts is the larger complexity due to lengthy contracts and risk sharing (HM Treasury, 2012).

According to past experiences in the construction industry of the United Kingdom, PFI contracts have the following weaknesses (HM Treasury, 2012, p. 6):

- The tendering or procurement proceeds very slow, which led to extra costs for both the public- and private sector and reduced value for money (transaction costs).
- PFI contracts have no room for flexibility, while the scope changes are dynamic. Therefore, it is hard to compare the perceived performance with the actual performance.
- The normal taxpayer has no insight into the long term debts of PFI projects and the returns for investors in the project.
- The unforeseen risks are transferred to the private sector, which eventually can result in a higher risk premium for the public sector.
- Private capital investors just want easy gains from the project instead of other values.
### APPENDIX C: CASE STUDY SELECTION

<table>
<thead>
<tr>
<th>Possible case study project</th>
<th>Sector</th>
<th>Project type</th>
<th>Project phase</th>
<th>Contract type</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schipol-Amsterdam-Almere (SAA-One)</td>
<td>Infra</td>
<td>Road/bridge</td>
<td>Build</td>
<td>DBFM</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A9-Badhoevedorp</td>
<td>Infra</td>
<td>Road/crossover</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A2 Maastricht</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>D&amp;B</td>
<td>Ballast Nedam</td>
</tr>
<tr>
<td>Haak om Leeuwarden</td>
<td>Infra</td>
<td>Road/crossover</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>A15 Maasvlakte-Vaaplein</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>DBFM</td>
<td>Ballast Nedam</td>
</tr>
<tr>
<td>A4 Delft-Schiedam (A4DS)</td>
<td>Infra</td>
<td>Road</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Zuidasdok</td>
<td>Infra</td>
<td>Road/rail/tunnel</td>
<td>Design</td>
<td>D&amp;C</td>
<td>?</td>
</tr>
<tr>
<td>Galleri-Putzerbouw</td>
<td>Infra</td>
<td>Road/bridge</td>
<td>Build</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Maximakanaal</td>
<td>Infra</td>
<td>Channel</td>
<td>Finished</td>
<td>D&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Oosterscheldekering (OSK)</td>
<td>Infra</td>
<td>Road/Barrier</td>
<td>Build</td>
<td>Maintenance</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Dordrecht Station Utrecht (DSU)</td>
<td>Infra</td>
<td>Rail</td>
<td>Build</td>
<td>OPC</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Maassluis 2</td>
<td>Infra</td>
<td>Land reclamation</td>
<td>Maintenance</td>
<td>DCM</td>
<td>Boskalis/van Oord</td>
</tr>
<tr>
<td>Zoo Emmen (Wildlands)</td>
<td>Real Estate</td>
<td>Zoo</td>
<td>Build</td>
<td>E&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>International Criminal Court (ICC)</td>
<td>Real Estate</td>
<td>Building</td>
<td>Build</td>
<td>E&amp;C</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>City Hall + Station Hall Delft</td>
<td>Real Estate</td>
<td>Building</td>
<td>Build</td>
<td>Traditional</td>
<td>BAM</td>
</tr>
<tr>
<td>Stroomversnelling</td>
<td>Energy</td>
<td>Building</td>
<td>Build</td>
<td>Traditional</td>
<td>VolkerWessels</td>
</tr>
<tr>
<td>Cable connection Roggeplaat-HVS</td>
<td>Energy</td>
<td>Cable connection</td>
<td>Build</td>
<td>Traditional</td>
<td>VolkerWessels</td>
</tr>
</tbody>
</table>

Table 8: Possible projects for case study research (Heeringa, 2015)

In Table 8 several construction projects which are currently topical in the Netherlands are stated which are investigated to be applicable for the case study research of this report. On top of the table the project characteristics are formulated which indicate the scope of this research, stated in chapter 2.3. The projects should be carried out in the infrastructure sector, they should contain typical infra properties, they should be in the building phase or further, they should have an integrated contract and they should be executed within the VolkerWessels organization. If the characteristic of the project matches with the scope, it is marked green. If the characteristic does not match with the scope, it is marked red. One exception is marked orange, because it is a special case.

Because of the limited time to conduct the research, but still enough different information has to be gained, there is chosen to select six projects for the case study research. After gathering some information about all projects in table 1, eight projects are eligible, because they meet all scope characteristics. After that, there is chosen to eliminate the two road infrastructure projects ‘A9-Badhoevedorp’ and ‘Haak om Leeuwarden’, because still two road projects remain. Therefore, a variation of project types will be investigated to get a good comparison. It becomes clear from the project types which projects are line- or point infrastructure projects, which creates variety in the selection. The ‘Wildlands zoo Emmen’ project is a real estate project, but because it is an environment instead of a building and the SRM in this project has many similarities with infrastructure, it falls within the boundaries of the scope. The ‘Oosterscheldekering’ project only has one characteristic which does not match the scope, but because this is only a maintenance project, the SRM situation is not interesting enough. The six selected case study projects all have key stakeholders which are easily accessible within the VolkerWessels organization, which makes it possible to collect a lot information in a relatively short time.
APPENDIX D: INTERVIEW PROTOCOL

This interview protocol is written for the case study research, which is part of a master thesis. The master thesis is written by Tom Heeringa for the master Construction Management & Engineering at the Delft University of Technology. The subject of the master thesis is about Stakeholder Relationship Management: on complexity and integrated contracts during Large Infrastructure Projects. The case studies are selected according the scope (2.3) of this thesis. This appendix will further elaborate the goal, strategy and structure of the executed interviews and the choice for particular interviewees.

INTRODUCTION

Information from interviews can be gathered in a structured or unstructured way. In a completely structured interview is the starting point a questionnaire or survey, in which the questions and possible answers are fixed. The interviewer should ask these questions in a specific order, without skipping or distorting the questions. Open interviews are not completely structured, causing interviewers to respond flexible on the situation. An open interview looks like a normal conversation with someone. The topics and mostly the starting questions of every topic are fixed, but in the rest of the interview questions can be added or changed dynamically. The reliability of an interview depends on the extent to which the results depend on coincidence. There are several ways to increase the reliability, like: the use of recording equipment, develop a personal opinion about the topic and interview multiple stakeholders (Baarda & de Goede, 2007).

Several interview types are used to gather information about the desired topics. The so called ‘free-attitude-interview’ is completely unstructured. In these interviews there is most of the time only a starting question and after that the interviewee gives an opinion about the topic, while the interviewer only deepens the topic. A ‘semi-structured interview’ has no previously fixed questions, but the topics are settled. These interviews start with structured questions about personal data, after which several prefixed topics are addressed through open questions. The ‘focused interview’ is a special interview form, where it is essential that all interviewees are in a similar situation and had similar experiences. These interviews are used to find out which elements of the situations evoke reactions and what kind of reactions. An ‘elite-interview’ is used when influential or powerful members of an organization or local community are selected for an open interview because of their expertise. The interviewees can give a good total image of their organization, including the past and future. The ‘retro-perspective interview’ is used when information needs to be gathered from the past. The interviewer should be alert that the image of the past could be influenced by a changed present situation (Baarda & de Goede, 2007).

Because this master thesis contains qualitative case studies, which each have a different character, the information is gathered with a semi structured interview. In that way, the interviewees can give a lot information without answering a few standard questions. The researcher can filter the information he needs from the open answers in order to collect the necessary data. The beginning of every separate interview is the same, with some questions about personal information and a similar starting question. Also a chronological ordered topic list is the same in every interview, but the sub questions and length of the answers can differ.

GOAL OF THE INTERVIEWS

The main goal of an interview is to gather information from responses of interrogated persons, giving answers to pre-formulated questions. The interview is a tool to gather empirical data, which will be used to answer one research question from the master thesis (Baarda & de Goede, 2007). These research questions are used to structure the research objective (2.2) of this research: “Understand current issues on complexity and integrated contracts that influence SRM and develop a solution to improve the execution of SRM in LIPs”. Multiple interviewees with different perspectives on the particular case will be selected, like contractors, clients and civilians, to get an unbiased point of view. The outcome of the interviews should be a set of information from project managers who experienced SRM during the projects which are selected for the case studies. The information will be used to collect data about the same components as the literature study of the master thesis: SRM, complexity and PPPs. The interviews are conducted for this research only and the results are stated in the case study research (4).
INTERVIEW STRATEGY

Preparation
At first, the desired respondents were notified through e-mail, with a short introduction about the master thesis and the question if they wanted to be interviewed about the project where they work or have worked. The objective of the master thesis and the reason why the specific project is selected for a case study research was elaborated. A few weeks later, the respondents who agreed to be interviewed where notified to make an appointment and a topic list for the interview was announced through e-mail.

Informing participants
The following information about the interview was given when the appointment was made through e-mail:

- It is a semi structured interview with three fixed topics and starting questions.
- The focus will be on the previously discussed project, which is finished or still ongoing.
- The interview should take approximately 50 to 70 minutes.
- A recording device will be used, unless there is objection to it, to record the interview. These recordings are used when the researcher wants to retrieve detailed information on some questions.
- The notes and recordings are used only for this research, executed for VolkerInfra and the TU Delft.
- The elaboration of the interview can be checked on reliability by the interviewee if they want that.
- An estimation of the interview consists of the following structure:
  - Introduction (5 minutes)
  - Background information (10 minutes)
  - Topic one: Stakeholder Relationship Management (15 minutes)
  - Topic two: Complexity (15 Minutes)
  - Topic three: Integrated contracts (10 minutes)
  - Closing (5 minutes)
- If the interviewees can add information about the topic or project which the interviewer possibly has forgotten, than they are free to add it anytime.

Information gathering prior to the interview
After that, information was gathered about the specific case projects prior to the interviews. All factual information which could be gathered from internet and literature is elaborated stated in the case descriptions in the case study research (4). This contains data about the scope, objective, contractual arrangements and duration of the project. In this way an unbiased point of view could be taken towards the project about the topics which would be discussed during the interview. A good preparation avoids unnecessary questions which could have been looked up in advance. The interviewees should give their own perspective on the topics, too ensure an objective research with personal- and factual viewpoints.

Behavior of the interviewer
There are several techniques and behavioral trainings to conduct a professional interview. In ‘basisboek interviewen’ (Baarda & de Goede, 2007) and ‘Craftways’ (Wildavsky, 2010) these techniques and trainings are elaborated to cope with silences, stimulating, counter questions, getting deeper into topics and flexibility. The following techniques will be used by the interviewer to let the interview run smoothly:

- Difficult long sentence structures will be avoided in the questions.
- The interviewer will not take a standpoint on the case, but shows knowledge of the facts.
- Easy topics will be addressed first, with a broad starting question and more specific sub-questions.
- An experimental interview will be conducted with a participant who can be interviewed several times.
- To create a comfortable situation the interviewer can start with a conversation about the daily life.
- The questions should not contain guiding or suggestive elements, which influence the answers.
- Ask one question at the time and maintain the silence before adding another question.
- Do not interrupt when a silence holds more than ten seconds, rephrase the question if necessary.
- Stimulate the interviewee non-verbal with facial appearances, vocalization and an attractive posture.
- Stimulate the interviewee verbal with insertions like “hm-mm” and keep questioning about interesting sub topics when you need more information.
- Finish the interview with questions about the interview process and possible additions.
INTERVIEW STRUCTURE (ENGLISH)

The interview structure is written in Dutch and English, because the interview will be held in Dutch, but the master thesis is written in English. The interview starts with an introduction about the purpose and objective of the research. Furthermore, some background information will be gathered from the interviewee to create the setting of the case. The actual body of the interview contains three main topics with fixed starting questions and several sub topics which should be addressed. In the end the closure is used to conclude the interview.

Introduction
As discussed in our contact through e-mail I am going to interview you about the project where you are currently working on, or have worked on. This interview is part of my graduation research, which I am performing on behalf of the Delft University of Technology at VolkerInfra. During the interview I want to use a recording device to retrieve details of this conversation afterwards. If you have objections against the recordings you can indicate that before the interview. The records of this interview will only be used for this research, on behalf of VolkerInfra and the Delft University of Technology. The elaborated interview can be sent to the interviewee afterwards, to check it on reliability and truth.

The purpose of this interview is to get a better insight in the complexity and responsibility division in executing Stakeholder Relationship Management in Large Infrastructure projects. Six Large Infrastructure Projects with different characteristics are selected within the Dutch construction industry, which serve as case studies. To get an objective image of the situation, multiple persons with different perspectives are interviewed. After the interviews I will apply a ‘cross case’ analysis to draw conclusions. These conclusions cannot be seen as right or wrong, because it is for the purpose of a scientific research. The interview will start with questions about your personal background, to create the setting of the case. After that, the three topics will be addressed, which have been previously announced to you by e-mail. The interview will take approximately one hour, after which there is a possibility to add information that I may have overlooked. If you have no questions I will start the interview.

Background information
I would like to collect some personal background information from you, in order to demonstrate possible differences or similarities with other interviewees. This information will be used anonymous in the research, which safeguards your personal information and contributes to an objective research.

- Can you describe the function and activities you execute within the project?
  - Function and responsibilities
  - Preparatory education
  - Previous work experience in this field
  - Role of the organization in this project
  - Number of controlled employees

Topic one: Stakeholder Relationship Management
The main topic deals with the application of SRM in the project. A discipline which have been executed for centuries, but which only has been recorded for several years. In a world where infrastructure projects are getting increasingly complex, SRM becomes more and more important.

- How is SRM applied in the project?
  - Used methods and structure
  - Together or individual approach
  - Crucial moments regarding stakeholder relationship management (examples)

- With which stakeholders did the project organizations have to deal?
  - Stakeholders in the environment
  - Problems with important stakeholders
  - Degree of participation and approaching stakeholders
  - Dynamic stakeholders with changing demands during the project
What do you think of the currently used methods regarding SRM?
- Twynstra Gudde: Mutual gains concept
- Wesselink: Strategisch omgevingsmanagement (SOM)
- Rijkswaterstaat: Integraal project management (IPM)
- Advantages and disadvantages

Topic two: Complexity
_The second topic concerns complexity, which occurs basically in every large infrastructure project._

- Can you tell something about the complexity of the project?
  - Project size in stakeholder relationships
  - Project size in terms of financing
  - Amount of requested permits
  - Amount and difficulty of civil works
  - Difficult organization structure
  - Time pressure

- What made the project complex?
  - Conflicts within the project organization
  - Relation with surrounding stakeholders
  - Delays during the execution
  - Troubles with requesting permits
  - Application of difficult or new techniques
  - Budget overruns

- What do you think about the way in which the organization dealt with complexity in this project?
  - From the perspective of the client
  - From the perspective of the contractor
  - Possible improvements for the future
  - Dynamic complexity

Topic three: Integrated contracts
_The following questions concern the second topic: integrated contracts, where a governmental organization is the client and a building company is the contractor._

- How were the responsibilities divided between client and contractor?
  - Responsibilities for the client
  - Responsibilities for the contractor
  - Collaboration between client and contractor
  - Problems between client and contractor

- Can you tell something about the used contract type during the project?
  - Advantages of an integrated contract
  - Disadvantages of an integrated contract
  - Responsibilities defined in the contract
  - Possibilities for other contract types

- How do you think about the responsibility division between client and contractor?
  - Division of possible risks between client and contractor
  - Perform collectively and come forward as one organization
  - Changes in responsibility division during the project
  - Meeting the expectations as described in the contract
Closure

This is the last part of the interview after the main part of the interview.

- Do you have substantive additions which could be applied to the research?
  - Questions which should have been asked
  - Things which must be done better in future interviews

Hereby I want to thank you for your time and the answers the stated questions. As mentioned before, the answers will be used only for the use of the graduation research. If you want to check the elaborated interview on factual inaccuracies you can always contact me to see the interview.

INTERVIEW STRUCTURE (DUTCH)

De opbouw van het interview is geschreven in het Nederlands en in het Engels, omdat het interview in het Nederlands gehouden wordt, maar de master thesis is in het Engels geschreven. Het interview start met een introductie over het nut en het doel van het onderzoek. Daarna zal er achtergrond informatie gevraagd worden aan de geïnterviewde persoon, om de setting van de case te beschrijven. De kern van het interview bestaat uit drie hoofdonderwerpen met vaste beginvragen en meerdere deelonderwerpen die aan bod moeten komen. Als laatst is de afsluiting een mogelijkheid om het interview samen te vatten en te concluderen.

Introductie

Zoals afgesproken in ons mailcontact ga ik u interviewen over het van te voren besproken project, waar u werkzaam bent, of heeft gewerkt. Dit interview is onderdeel van mijn afstudeeronderzoek, welke ik uitvoer in opdracht van de TU Delft bij VolkerInfra. Tijdens het interview wil ik opnameapparatuur gebruiken om later details terug te kunnen luisteren. Als u daar bezwaar tegen hebt kunt u dat van tevoren aangeven. De aantekeningen en opnames van dit interview zullen alleen voor dit onderzoek gebruikt worden, in opdracht van de TU Delft en VolkerInfra. Achteraf kan het uitgewerkte interview opgestuurd worden naar de geïnterviewde persoon, zodat het gecontroleerd kan worden op betrouwbaarheid en waarheid.

De bedoeling is dat ik een beter inzicht krijg in de uitvoering van omgevingsmanagement ten aanzien van de toenemende complexiteit en de introductie van geïntegreerde contracten. Er zijn zes grote infrastructurele projecten met verschillende eigenschappen geselecteerd binnen Nederland, die dienst doen als case studies. Om een objectief beeld te krijgen van de situatie worden er meerdere mensen met verschillende perspectieven geïnterviewd. Na de interviews zal ik een ‘cross-case’ analyse toepassen om conclusies te trekken. Deze kunnen niet als goed of fout worden beschouwd, want het betreft een wetenschappelijk onderzoek. Het interview zal starten met vragen over uw persoonlijke achtergrond, om de setting van de case te creëren. Daarna zullen de drie onderwerpen aan bod komen, welke eerder per mail aan u bekend gemaakt zijn. Het interview zal ongeveer een uur in beslag nemen, waarna er gelegenheid is om informatie toe te voegen die ik mogelijk over het hoofd heb gezien. Als u verder geen vragen heeft zal ik beginnen met het interview.

Achtergrondinformatie

Graag zou ik eerst wat persoonsgegevens van u te weten komen, zodat ik eventuele verschillen of overeenkomsten kan aantonen met andere geïnterviewde personen. Deze gegevens zullen anoniem in het onderzoek gebruikt worden, zodat het onderzoek objectief blijft en uw gegevens gewaarborgd.

- Kunt u de functie en werkzaamheden die u uitoefent binnen het project beschrijven?
  - Functie en verantwoordelijkheden
  - Aansluitende vooropleidingen
  - Eerdere werkervaring op dit gebied
  - Rol van organisatie in het project
  - Aantal aangestuurde werknemers in het project
Topic één: Omgevingsmanagement
Het eerste topic gaat over de toepassing van omgevingsmanagement in het project. Een discipline die al eeuwen onbenoemd wordt toegepast, maar pas sinds enkele jaren echt wordt beschreven. In de wereld van steeds complexer wordende infrastructurele projecten wordt omgevingsmanagement steeds belangrijker.

- Hoe is omgevingsmanagement in het project toegepast?
  - De gebruikte methode en structuur
  - Samen of individuele aanpak
  - Cruciale momenten met betrekking tot omgevingsmanagement
  - Voorbeelden van scenario’s

- Met welke stakeholders heeft de projectorganisatie te maken gehad?
  - Stakeholders in de omgeving
  - Problemen met belangrijkste stakeholders
  - mate van participatie en benaderen stakeholders
  - Dynamische stakeholders met veranderende belangen tijdens het project
  - Protocol bij crisissituatie en rollerdeling

- Wat vindt u van de huidige methoden op het gebied van omgevingsmanagement?
  - Twynstra Gudde: Mutual gains concept
  - Wesselink: Strategisch OmgevingsManagement (SOM)
  - Rijkswaterstaat: Integraal Project Management (IPM)
  - Voordelen en nadelen modellen

Topic twee: Complexiteit
Het tweede topic betreft complexiteit, wat in principe in elk groot infrastructureel project voorkomt.

- Kunt u wat vertellen over de complexiteit van het project?
  - Projectomvang in stakeholder relaties
  - Projectomvang op het gebied van financiering
  - Hoeveelheid aangevraagde vergunningen
  - Hoeveelheid en moeilijkheid kunstwerken
  - Lastige organisatie structuur
  - Tijdsdruk tijdens uitvoering

- Wat maakte het project complex?
  - Conflicten binnen projectorganisatie
  - Relatie met omliggende partijen
  - Vertragingen tijdens de uitvoering
  - Strubbelingen bij vergunningen aanvragen
  - Toepassen van moeilijke of nieuwe technieken
  - Budget overschrijdingen

- Wat vindt u van de manier waarop men is omgegaan met complexiteit in dit project?
  - Vanuit de opdrachtgever
  - Vanuit de opdrachtnemer
  - Verbeteringen voor toekomstige omgang met complexiteit
  - Dynamische complexiteit

Topic drie: Geïntegreerde contracten
De volgende vragen gaan over het derde topic: geïntegreerde contracten, waarbij de overheid de opdrachtgever is en de aannemer de opdrachtnemer.
Hoe waren de verantwoordelijkheden tussen opdrachtgever en opdrachtnemer verdeeld?
- Verantwoordelijkheden voor de opdrachtgever
- Verantwoordelijkheden voor de opdrachtnemer
- Samenwerking tussen opdrachtgever en opdrachtnemer
- Problemen tussen opdrachtgever en opdrachtnemer

Kunt u wat vertellen over de contractvorm die gebruikt is tijdens het project?
- Voordelen geïntegreerd contract
- Nadelen geïntegreerd contract
- Verantwoordelijkheden vastgelegd in contract
- Mogelijkheden andere contractvormen

Wat vindt u van de verantwoordelijkheidsverdeling tussen opdrachtgever en opdrachtnemer?
- Verdeling van eventuele risico’s tussen opdrachtgever en opdrachtnemer
- Gezamenlijk naar buiten treden als één organisatie
- Veranderingen in verantwoordelijkheidsverdeling tijdens project
- Voldaan aan de in het contract beschreven verwachtingen

Afronding
Dit is na de kern van het interview het laatste gedeelte van het interview.

Heeft u nog inhoudelijke toevoegingen die van toepassing kunnen zijn voor het onderzoek?
- Niet gestelde vragen
- Dingen die in het vervolg anders zouden kunnen

Ik wil u bij deze hartelijk bedanken voor uw tijd en het beantwoorden van de gestelde vragen. Zoals eerder verteld zullen de antwoorden uitsluitend gebruikt worden voor het afstudeeronderzoek. Als u het uitgewerkte interview wilt controleren op feitelijke onjuistheden kunt u mij altijd contacteren om het in te zien.
APPENDIX E: INTERVIEW REPORTS

This appendix has been intentionally left out the public report, because the content is confidential.
### APPENDIX F: CROSS-CASE ANALYSIS

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<tr>
<td>A standard method for the execution of SRM</td>
<td>On the side of the client SRM was executed according the standard IPM and SOM models as stated in the contract, but on the side of the client SRM was executed based on own experiences.</td>
<td>Both client and contractor executed SRM according the IPM and SOM methods, but the principle of the methods was more important: taking the demands and interests of stakeholders into account.</td>
<td>Although the client used an IPM model to structure SRM, there was no standard method for the execution of SRM on both sides. SRM was based on personal experience and investing in the relationship with stakeholders.</td>
<td>Although the client used an IPM model to structure SRM, there was no standard method for the execution of SRM on both sides. The execution was based on personal experience and common sense.</td>
<td>There was no used current method as a standard for the execution of SRM, but several supporting models made by the contractor, like a less nuisance model, standardized SRM in a way.</td>
<td>There was no standard method for the execution of SRM, which was not even a separate discipline with a SRM manager. SRM tasks were divided among client and contractor and were based on personal experience.</td>
</tr>
<tr>
<td>Client and contractor act together in executing SRM</td>
<td>Both SRM managers, collaborated sparsely and stakeholders were divided, just like the contract. The contractor thinks that earlier contractor involvement would have tackled several issues.</td>
<td>There was not much collaboration in the engagement of stakeholders, but client and contractor supported each other when it was necessary.</td>
<td>Collaboration was very important in the execution of SRM managers. Both SRM managers did almost everything together in consultation, SRM was executed independent from the contract, which paid off well.</td>
<td>Collaboration between the SRM managers is seen as the key factor for success in this LIP. They went through fire and water for each other and there was much mutual trust and respect between the managers.</td>
<td>Both SRM managers of client and contractor collaborated a lot, but it has to be emphasized that this was devoted to the relationship between both SRM managers and not to the contract, which was very strict.</td>
<td>The SRM tasks were clearly divided among managers, which caused only few collaboration in SRM. Actually the main stakeholder, the municipality, engaged most of the other stakeholders.</td>
</tr>
<tr>
<td>Crucial moments/ issues regarding SRM</td>
<td>Most issues occurred with the misinterpretation of OVIs (execution agreements), because a grey area emerged between stakeholders and the contractor about agreements.</td>
<td>The main issues occurred due to the fact that the project crossed four different municipalities, with different landscapes and different stakeholders.</td>
<td>Some crucial issues occurred during the project, like much noise nuisance during one night, but with openness and collaboration between the SRM managers these could be solved.</td>
<td>The respondents did not mention any significant issues regarding SRM, which makes this successful project an example for the execution of SRM.</td>
<td>Most issues occurred due to the adjustment of all the stakeholder’s interests, to get good construction windows where everybody agreed upon.</td>
<td>There were not real significant issues during the project, mainly because the area was cleared before the construction and not much stakeholders were involved.</td>
</tr>
<tr>
<td>Participation with stakeholders</td>
<td>There was not much room for participation with stakeholders due to the narrow scope of the DBFM contract, but the respondents think that more participation would have been better to solve issues.</td>
<td>Participation was an important aspect in this LIP, because many stakeholders were against the project and 50 years of history led to many ideas from many different stakeholders.</td>
<td>Participation with stakeholders during this project was inevitable, because many traffic organizations had to use the bridge and channel during the construction.</td>
<td>Participation has proven to be a very important factor in this project and also went very well. For example, the design of a lock was changed due to the concerns of specialized stakeholders.</td>
<td>Participation was important during this LIP, because many organizations had to make use of the railway tracks and central station during the execution.</td>
<td>Participation was very important, because the main stakeholder was also partly client, which made participation inevitable.</td>
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<td>Changing interests/needs of stakeholders</td>
<td>Long change processes had to be executed with VTOs (amendment requests) and LTOs (amendment by client), due to the misinterpretation of agreements, leading to delays.</td>
<td>Several important stakeholders changed their interests and demands because they could have influence on the project through participation.</td>
<td>There were no significant changes in the execution of SRM. Probably much changes were overcome because the phase of SMP was executed in an early stage.</td>
<td>The respondents also did not mention significant changes during the UP. This was likely caused by the information sharing, transparency and traceability were key words.</td>
<td>Many changes occurred due to the changing interests of the client, who still did not exactly know what they wanted when the project had already started.</td>
<td>Small changes occurred during the execution due to changed preferences of the client, but these changes could be solved within the project budget.</td>
</tr>
<tr>
<td>View on currently used models like SOM</td>
<td>All respondents think that the current methods for SRM are good handrails, but the execution of SRM depends very much on the relationship between the SRM managers and boundaries of the contract.</td>
<td>The principles of SOM and mutual gains about collaboration are very clear and important, but the lack of flexibility in the contract obstructs successful application of the methods.</td>
<td>The current approaches like SOM and mutual gains are good guidelines for SRM, but the philosophy of integrated contracts stands perpendicular on the approaches and make it hard to apply them in practice.</td>
<td>It is hard to apply the current SRM methods in integrated contracts, because there is not much flexibility in these contracts. The principles must be applied between client and contractor outside the contract.</td>
<td>It would be good in general to create a certain standard structure for the execution of SRM, but it is not sure that the current methods are good enough to be that standard.</td>
<td>A standard method with the support of software tools is seen as an improvement for the execution of SRM in the future.</td>
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Table 9: Cross-case comparison SRM (Heeringa, 2015)
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<tr>
<td>Social complexity</td>
<td>Most difficult: Taking the different interests of all stakeholders into account and meeting the agreements was a very busy task.</td>
<td>Most difficult: Differing interests of many stakeholders through four municipalities are causing social complexity since the 1950s and is therefore the most difficult complexity.</td>
<td>Very difficult: Because the bridge and channel had to be used by several organizations during the construction it was very important to adjust the interests to each other.</td>
<td>Very difficult: Although SRM was executed very well in this project, still a lot stakeholders were involved.</td>
<td>Very difficult: Adjusting the interests of all stakeholders to each other the create good construction windows was very hard.</td>
<td>Not difficult: The construction area was cleared from stakeholders in the preparation phase. The project organization did not have to execute much stakeholder management.</td>
</tr>
<tr>
<td>Technical complexity</td>
<td>Not difficult: Although there were a lot civil large civil works, the building methods were relatively standard.</td>
<td>Very difficult: After social complexity, the technical complexity of the tunnel installations and water management in the deepened highway is the most difficult.</td>
<td>Most difficult: There was not much knowledge about the fatigue steel in the bridge, which asked for an innovative solution and difficult working method.</td>
<td>Most difficult: Many new installations like locks and pumping stations with the newest technologies had to be installed.</td>
<td>Not difficult: All used techniques were implemented in earlier projects.</td>
<td>Very difficult: The unique character of the project caused several difficulties in the construction of the special structures.</td>
</tr>
<tr>
<td>Organizational complexity</td>
<td>Very difficult: A project with this size needed a large project team which expanded from 25 to 500 members in a short time, making it very complex.</td>
<td>Very difficult: The structure of the project organization with a management contractor as co- client caused several issues.</td>
<td>Not difficult: This was actually managed very well.</td>
<td>Most difficult: Collaborations between client and contractor were messy and differences between internal contractor organisations caused discussions.</td>
<td>Not difficult: The unique character caused difficulties in adjusting all sub teams to each other and the municipality was main stakeholder and also client which caused difficulties.</td>
<td></td>
</tr>
<tr>
<td>Legal complexity</td>
<td>Not difficult: Although many permits had to be requested in short periods, the actual permits were not hard to get.</td>
<td>Also difficult: Requesting environmental permits for this highway caused much resistance in this natural area.</td>
<td>Not difficult: Many permits had to be requested, but they were not very hard to get.</td>
<td>Not difficult: Over 750 permits had to be requested, but they were not very hard to get.</td>
<td>Not difficult.</td>
<td>Not difficult: Most permits were requested at the municipality, who also were the co-client.</td>
</tr>
<tr>
<td>Financial complexity</td>
<td>Also difficult: Due to the finance component in the DIFFM contract the deadline became even more important, otherwise the insistence would be higher than the gains of the UP.</td>
<td>Not difficult</td>
<td>Not difficult</td>
<td>Not difficult</td>
<td>Not difficult</td>
<td>Also difficult: The largest contract sum in the history of railway projects placed extra pressure on all managers.</td>
</tr>
<tr>
<td>Time Complexity</td>
<td>Not difficult: The deadline was very important, but that was caused by financial complexity, the project will be even finished before the deadline.</td>
<td>Not difficult: After the project was granted in 2011 time complexity was not a large issue anymore.</td>
<td>Not difficult: Adjusting the construction windows on all stakeholder interests was difficult but it all worked out.</td>
<td>Also difficult: Getting all the work done before the deadline caused some difficulties in the planning.</td>
<td>Also difficult: Constructing a railway project while all rail traffic had to continue caused difficulties in the planning.</td>
<td>Not difficult: The project will be delivered in time.</td>
</tr>
<tr>
<td>Dynamic complexity</td>
<td>Very difficult: Misinterpretation about the agreements in the execution agreements caused changes which had to be implemented by the contractor.</td>
<td>Not difficult: No major changes occurred during the execution of this UP.</td>
<td>Very difficult: The static integrated contract had not much flexibility, which made the inevitable contract changes difficult to manage.</td>
<td>Also difficult: Changes were inevitable due to changed preferences of the client.</td>
<td>Not difficult</td>
<td>Also difficult: The client did not exactly know what they wanted at the start, which caused many changes during the project.</td>
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Table 10: Cross-case comparison complexity (Heeringa, 2015)
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<tr>
<td>Strictness of the responsibility division client-contractor</td>
<td>There was a strict responsibility division in this project. The DBFM contract did not stimulate collaboration and flexibility.</td>
<td>The contract contained strict responsibility divisions between client and contractor, but they supported each other where needed.</td>
<td>The tasks were strictly divided in the contract, but the SRM managers shared their responsibilities and discussed everything in an open way.</td>
<td>In the beginning all tasks were strictly divided as stated in the contract, but during the project some SRM managers divided all tasks in consultation and also shared tasks.</td>
<td>The responsibilities were strictly divided between client and contractor. At some points they were in a competition instead of in a team.</td>
<td>There was no clear responsibility division because there were two clients and one contractor with a D&amp;C contract based on a model instead of written agreements.</td>
</tr>
<tr>
<td>Advantages of the integrated contract</td>
<td>Much freedom in the design and other aspects should be a great advantage, if everything was prefixed and changes were not requested.</td>
<td>The freedom to adjust the design to the construction is an advantage.</td>
<td>If the D&amp;C contract was implemented in a normal way it could have much advantages, but this was not the case.</td>
<td>The field of SRM was executed in an alliance or ‘bouwteam’ kind of way, which was not the same as the initial D&amp;C contract.</td>
<td>An advantage of the D&amp;C contract should be the design freedom, but the client already made the design over the past fourteen years.</td>
<td>The contractor had much freedom to create a good project within the ceiling price.</td>
</tr>
<tr>
<td>Disadvantages of the integrated contract</td>
<td>The integrated contract was very static and there was no room for flexibility. The F component furthermore laid extra pressure on the deadline.</td>
<td>Misinterpretations during the design phase lead to discussions and changes in the execution phase.</td>
<td>Although the D&amp;C contract should have much freedom in the design, but the management contractor elaborated the design already very far.</td>
<td>Flexibility and sharing tasks is difficult in this contract, therefore the SRM part is executed in an alliance or ‘bouwteam’ kind of way.</td>
<td>The responsibilities were not evenly divided, mainly because the client had too much advantages due to an earlier start.</td>
<td>Many changes occurred due to the changing demands of the client. These were hard to implement because of a ceiling price.</td>
</tr>
<tr>
<td>Collaboration outside the contract</td>
<td>There was not much collaboration outside the contract, the activities were strictly divided. Nevertheless both sides supported each other when it was necessary.</td>
<td>The collaboration between client and contractor went well in the field of SRM, but they did not act together in engaging stakeholders.</td>
<td>Collaboration in the field of SRM and openness to each other was agreed upon on beforehand between both SRM managers and proved to be very successful in SRM activities.</td>
<td>The fact that both SRM partners wanted to adopt more tasks than agreed upon shows that they were willing to collaborate and had mutual respect for each other’s interests.</td>
<td>Although the responsibilities were strictly divided, both SRM managers were collaborating on SRM tasks. This worked pretty well but was not intended in the contract.</td>
<td>The normal collaboration between the clients and the contractor elapsed very well, but they did not share tasks or responsibilities.</td>
</tr>
<tr>
<td>View on integrated contracts in general</td>
<td>Adding more flexibility and collaboration in the contract would be improvement, because in current LIP the contractors can not always deal with the given risks.</td>
<td>Increasingly more responsibilities are shifted to the private market over the past several years, but collaboration is inevitable to solve particular problems.</td>
<td>Current integrated contracts are very static and ‘stick to the plan’. There is no room for flexibility and collaboration, which has to be added by the SRM managers themselves.</td>
<td>The tendency in the current integrated contracts is the fact to the client feels that everything is fixed and responsibilities lay with the contractor, while collaboration sometimes is more profitable.</td>
<td>These type of projects should be executed with alliance or ‘bouwteam’-type of contracts, because in that case both client and contractor start at the same time and they have the same interests.</td>
<td>Too much risks are shifted to the contractor in the current integrated contracts, because the contractor is not always able to deal with particular risk.</td>
</tr>
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</table>

Table 11: Cross-case comparison integrated contracts (Heeringa, 2015)
APPENDIX G: TOOL WORKSHOP, NIEUWE SLUIS TERNEUZEN

Voor dit onderzoek is een model ontwikkeld ten behoeve van de uitvoering van omgevingsmanagement, aan de hand van een literatuurstudie en case studies. Deze workshop is bedoeld om de toepasbaarheid van het model te evalueren. Aan de hand van een gegeven case beschrijving over een actueel infrastructuurproject in Nederland zullen de deelnemers een stappenplan volgen. Uit dit stappenplan volgt een visualisatie van de verantwoordelijkheidsverdeling tussen opdrachtgever en opdrachtnemer. De workshop bestaat uit drie rondes waarin de case mee verandert: de design fase, construct fase en maintenance fase. De deelnemers vormen koppels van twee personen, één deelnemer speelt opdrachtgever en de andere deelnemer opdrachtnemer. Aan het eind is er ruimte voor opmerkingen die mee worden genomen in de ontwikkeling van het model.

CASE BESCHRIJVING, NIEUWE SLUIS TERNEUZEN

Het sluizencomplex bij Terneuzen is de toegangspoort van de Westerschelde naar de havens van Terneuzen en Gent, welke zijn verbonden door een kanaal. Deze havens zorgen voor veel werkgelegenheid en zijn belangrijke economische punten voor Nederland en Vlaanderen. Steeds meer en steeds grotere schepen zorgen ervoor dat de maritieme bereikbaarheid van de havens wordt beperkt door de capaciteit en afmetingen van het huidige sluizencomplex. Het economisch potentieel van deze ruimtelijk-economisch sterk gepositioneerde havenregio wordt op dit moment belemmerd om te groeien. Door de beperkte capaciteit worden ladingen verdrongen naar andere regio’s en neemt de wachttijd toe. De schaalvergroting van zeeschepen kan niet gevolgd worden door de afmetingen van de huidige zeesluis, zoals aangegeven in Figure 32 (LievenseCSO, 2015).

![Figure 32: Huidige situatie sluizencomplex met capaciteiten (Vlaams-Nederlandse Schelde Commissie, 2015)](image)

RONDE 1: DESIGN FASE


De grootste uitdaging van het project is dat de nieuwe sluis in het bestaande sluizencomplex gerealiseerd moet worden, zoals aangegeven in Figure 33, waarbij de huidige functies zoals scheepvaart en wegverkeer over de sluizen gewaarborgd moeten blijven tijdens de bouw. Aan het ontwerp zijn enkele eisen gesteld: in de sluizen moet het water op gelijk niveau worden gebracht met het kanaal of de Westerschelde door nivelleren, schepen mogen niet teveel manoeuvreren ten behoeve van de doorstroming en de sluisdeuren moeten bestand zijn tegen hoogwater en stormvloeden omdat ze onderdeel zijn van de primaire waterkering. Omdat de nieuwe sluis wordt gerealiseerd op de plek van een bestaande sluis en het bijbehorende stuk land zullen er veel kabels en leidingen verlegd moeten worden en twintig panden moeten worden opgekocht. Verder is er op het sluizencomplex een leefgebied ontstaan voor verschillende planten en dieren zoals de huismus, sintjansvlinger en de tongvaren, waar rekening mee gehouden moet worden. Tijdens een inspraakavond hebben bewoners van de binnenstad geprotesteerd omdat ze bang zijn voor verzakkingen en scheuren in gebouwen. Dit was ook het geval tijdens de bouw van de vorige sluis, die kleiner is, in de jaren 60. Ook informeren de havenbedrijven in Terneuzen en Gent regelmatig bij de VNSC over de hinder voor de scheepvaart tijdens de bouw.

Figure 33: Overlay van voorkeursvariant nieuwe sluis over huidige plattegrond (Vlaams-Nederlandse Schelde Commissie, 2015)
RONDE 2: CONSTRUCTION FASE

De tweede ronde speelt zich af in de uitvoeringsfase tussen 2017 en 2021, waarin de aannemerscombinatie en de opdrachtgever volop aan het bouwen zijn aan de sluis. De aannemerscombinatie heeft handig gebruik gemaakt van de 800 werkzoekende asielzoekers uit Syrië die gevestigd zijn op vakantie-eiland Marina Beach, door ze tegen een laag loon te laten werken aan dit gigantische project. Vanuit de landelijke politiek krijgt RWS veel commentaar op deze kostenbesparing en tijdelijke huisvesting van de arbeiders op het sluizencomplex. Daarnaast wil Brussel wijzigingen doorvoeren ten opzichte van mogelijke terreurdreiging. De sluis zijn kwetsbare objecten die door hun vitale economische- en waterkerende functies indirect een doelwit vormen voor internationale zeehavens en grote goederenstromen. Door de samenwerking met vluchtelingen als internationaal symbool voor vrede en de aanwezigheid van het grote Amerikaanse chemie bedrijf DOW Chemical op een kilometer afstand, is het sluizencomplex extra gevoelig voor een terroristische aanslag.

Aan het begin van de uitvoering worden de baggerwerkzaamheden in de havenmond bij de Westerschelde stilgelegd, omdat er gevaarlijke stoffen in de bodem zijn aangetroffen die waarschijnlijk afkomstig zijn van de fabriek van DOW Chemical. Het bedrijf beweert echter nooit buitenom de Europese richtlijnen afval te hebben geloosd. De logistieke dienstverlener Verbrugge Terminals (met locaties in Terneuzen, Vlissingen, Zeebrugge en Rotterdam) claimt bij de projectorganisatie dat er afspraken zijn gemaakt in de planfase met Rijkswaterstaat, over de beschikbaarheid van de huidige zeesluis tijdens de bouw. Deze afspraken zouden niet overeenkomen met de huidige hoeveelheid schepen die door de zeesluis de haven van Terneuzen kunnen bereiken. Verbrugge Terminals zegt miljoenen te zijn misgelopen, omdat de goederen via andere modaliteiten vervoerd zijn.

Later in de uitvoering blijken ook de omwonenden uit de binnenstad hun gelijk te krijgen. Tijdens het instorten van de damwanden zijn verschillende gebouwen gaan verzakken, waaronder het hoofdkantoor van Zeeland Seaports dat zich dicht bij het sluizencomplex bevindt. Daarnaast maakt de plaatselijke partij TOP gemeentebelangen zich sterk voor vermindering van de stikstofgehalte in de lucht. Deze overschrijdt de grenswaarde tijdens de bouw op bepaalde plaatsen door de oplopende wacht- en passeertijden van zowel zeevaart als wegverkeer.

RONDE 3: MAINTENANCE FASE

De laatste ronde betreft de maintenance fase van 2021 tot 2051, waarvoor een nieuwe aanbesteding is gedaan voor een maintenance contract van €82 Miljoen Euro. Het contract is gegund aan dezelfde aannemer, omdat de issues tijdens de uitvoeringsfase erg goed zijn opgelost in goede samenwerking met de opdrachtgever en het project binnen de tijd en het budget is gerealiseerd. Tien jaar na de aanbesteding van het contract blijkt dat de contractsom erg krap is begroot, vooral omdat de stormseizoenen in hevigheid zijn toegenomen. Dit kon tijdens de aanbesteding niet voorzien worden en zorgt ervoor dat de aannemer veel extra kosten moet maken om de sluisdeuren stormbestendig te houden. De aannemer zegt dat dit onder meerwerk moet vallen, maar Rijkswaterstaat zegt dat dit binnen het onderhoudscontract valt. In het jaar 2035 blijkt dat het waterpeil in de Westsluis regelmatig onder het toegestane niveau komt. Uit verder onderzoek is naar voren gekomen dat er een lek in de wand van de sluis zit en Rijkswaterstaat stelt dat dit door de bouw van de nieuwe Sluis komt. De aannemer denkt dat het niet door de bouw van de nieuwe sluis komt en verwacht dat het lek is ontstaan door schepen die de wal van de verouderde sluis erg vaak hebben geraakt. De aannemer wil het lek wel repareren, maar enkel als meerwerk bovenop het maintenance contract van de nieuwe sluis. Het is onduidelijk wie voor het herstel van dit lek op moet draaien.

In het jaar 2045 vaart een zeeschip tegen een van de nieuwe sluisdeuren aan en die is niet meer te herstellen. De verzekering van de scheepvaartmaatschappij dekt de schade, maar BAM en VolkerWessels krijgen een onderling geschil over wie dit meerwerk krijgt. Rijkswaterstaat probeert als bemiddelaar de beste oplossing te vinden voor iedereen, want het scheepvaartverkeer moet zo snel mogelijk weer op gang komen. Havenbedrijf Gent wil ook zo snel mogelijk de scheepvaart weer op gang krijgen, want de komst van een aantal grote schepen die enkel door de nieuwe sluis passen staat gepland.
STAPPENPLAN OMGEVINGS MANAGEMENT

Het is de bedoeling dat het stappenplan, zoals aangegeven in Figure 34, wordt gebruikt tijdens elke ronde. Dit stappenplan is naar voren gekomen uit verschillende huidige methodes die gebruikt worden voor de uitvoering van omgevingsmanagement zoals bijvoorbeeld SOM. De tools die naast het stappenplan zijn afgebeeld dienen als hulpmiddel tijdens het stappenplan en vormen gezamenlijk de solution tool van het afstudeeronderzoek. De tools in dit stappenplan zijn alvast ingevuld met een voorbeeld case om te laten zien hoe het werkt. Het is uiteindelijk de bedoeling dat de verantwoordelijkheidsverdeling met betrekking tot het oplossen van issues duidelijk wordt. De verantwoordelijkheidsverdeling is bedoeld voor de uitvoering van omgevingsmanagement en staat in de praktijk dus los van het contract. Of de verantwoordelijkheid in de praktijk letterlijk verdeeld kan worden volgens het model is afhankelijk van de flexibiliteit in het contract.

Figure 34: Stappenplan omgevingsmanagement met tools (Heeringa, 2015)
De matrix welke is weergegeven in Figure 35 is gebaseerd op het ‘core competentiemodel’ ontwikkeld door ‘Risk and Insurance Management Society’ (RIMS). Deze organisatie heeft een aantal componenten van risk management theorieën samengevat en hieruit een manier ontwikkeld waarmee de competentie van een manager te meten is. Na het invullen van de matrix met de cijfers 0 tot 10 rolt er een gemiddeld cijfer uit dat aangeeft hoe competent een manager is om de verantwoordelijkheid voor een issue op zich te nemen. Deze competentie is onderverdeeld in drie groepen vaardigheden: technische vaardigheden, persoonlijke vaardigheden en strategische vaardigheden. Op basis van de volgende uitleg per vaardigheid moeten de deelnemers zichzelf een cijfer kunnen geven:

- **Technical skills**: De operationele laag waarin de traditionele taken en gespecialiseerde vaardigheden naar voren komen. Een centrale vraag die hier gesteld kan worden: Heb ik de beste technische kennis en kunde om dit issue op te pakken?
  
  **Key words**: expertise, controleerbaarheid, haalbaarheid en project management.

- **Personal skills**: Dit zijn de zogenaamde ‘zachte’ management vaardigheden die de basis van het management van personen vormen. Een centrale vraag die hier gesteld kan worden: Hoe graag wil ik dit issue oplossen?
  
  **Key words**: motivatie, enthousiasme, innovatie en ervaring.

- **Strategic skills**: Dit is de strategische laag waarin de issues op waarde geschat worden en managers aanvoelen hoe de activiteiten in elkaar passen. Een centrale vraag die hier gesteld kan worden: Hoe belangrijk is dit issue en welke gevolgen heeft het voor mij?
  
  **Key words**: prioriteren, plannen, beslissingen nemen en gevolgen inschatten.
### PROJECT NAME: A1/A6 Diemen - Almere Havendreef

<table>
<thead>
<tr>
<th>Issue</th>
<th>Complexity</th>
<th>Social complexity</th>
<th>Technical complexity</th>
<th>Organizational complexity</th>
<th>Legal complexity</th>
<th>Financial complexity</th>
<th>Time complexity</th>
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<tbody>
<tr>
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<tr>
<td>B: Rugstreepad at junction Diemen</td>
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<td>C: House boats in the Amsterdam-Rijn Channel</td>
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<td>F: Railway crossing ProRail</td>
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</table>

Figure 36: Prioriteren van issues met complexiteiten (Heeringa, 2015)
Figure 37: Grid voor verantwoordelijkheidsverdeling (Heeringa, 2015)
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VolkerInfra

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