MASTER THESIS

Value management principles applied to opportunity and risk management processes

A case study for Rijkswaterstaat

Nikos Geerdink (s1742612)

Faculty of Engineering Technology
Civil Engineering and Management

EXAMINATION COMMITTEE
prof. dr. ir. L. Volker
dr. M. van Buiten
ir. B. de Groot

October 27, 2021

UNIVERSITY OF TWENTE.

Preface

This thesis is about applying value management principles to the opportunity and risk management process of Rijkswaterstaat. It finalizes my master study in Civil Engineering and Management at the University of Twente. This study is carried out in cooperation with Rijkswaterstaat from February 2021 to October 2021. Due to measures as the result of Covid-19 I was forced to execute this study depending on digital communication. Nonetheless, I am grateful for the online support offered by the University of Twente and Rijkswaterstaat within these circumstances. Therefore, I would like to thank my supervisors Leentje Volker, Marc van Buiten and Bert de Groot for their interest and feedback during this study. Furthermore, I would like to thank all participants from Rijkswaterstaat for their cooperation and time during the sessions organized be me. I hope you enjoy reading this report.

Nikos Geerdink

Hengelo, October 2021

Executive summary

In the construction industry, managing risks is of great importance to cope with uncertainties. However, the construction industry is characterised by high complexity and dynamics, resulting in high uncertainty and risk-levels. Currently, methods for managing risks are still developing. Additionally, the concept of risk has evolved from one focussing on the likelihood of a negative outcome, to a focus on both negative and positive outcomes, meaning that opportunities are involved too.

Several studies show that there are problems with the assessment of opportunities and risks. Rijkswaterstaat encounters similar problems, so a case study has been performed for this company. Rijkswaterstaat is the executive agency of the Dutch Ministry of Infrastructure and Water Management. Just as previous studies describe, they experience problems with the assessment of opportunities and risks. Specifically, they experience loss of value because for assessing opportunities and risks, the focus is too much on quantitative assessment, rather than qualitative assessment. Alongside this problem, Rijkswaterstaat has no view on how to increase value of the entire opportunity and risk management process.

To address this problem, value management principles were applied to increase value of the opportunity and risk management process of Rijkswaterstaat. Value management is a systematic and structured approach for improving projects, products, processes, services and organizations. The value management principles were applied as part of the methodology, meaning that certain aspects of the value management methodology are used for the methodology of this study. Also, value management principles were integrated in the redesign. To address both aspects, this study follows four phases.

The aim of the first phase is to determine aspects in the current opportunity and risk management process to increase value of. For this, current guidelines for opportunity and risk management at Rijkswaterstaat were analysed and seven semi-structured interviews with experts of Rijkswaterstaat were conducted. Based on this, three aspects were determined to increase value of. Based on the interviews; awareness, consensus and information exchange appear to be the most important aspects to increase value of in the opportunity and risk management process.

In the second phase, ideas were generated to increase awareness, create consensus and provide a better information exchange. For this, a brainstorm session was organized with a group of experts from Rijkswaterstaat related to opportunity and risk management. Subsequently, the generated ideas were rated in a voting session, as well with a group of experts from Rijkswaterstaat in the field of opportunity and risk management. The ideas and their ratings were analysed to determine three potential solutions. To create more awareness the proposal is to organize sessions in order to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. To achieve consensus in and across (a portfolio of) projects the proposal is to discuss strategies and analyses of opportunity and risk management on organizational level and project level to create a connection, and intensify coordination between the opportunity and risk management advisor and the advisor for portfolio management. To better exchange information in and across (a portfolio of) projects the proposal is to aggregate and simplify information to create a connection in and across (a portfolio of) projects.

In the third phase, all proposals were discussed with regard to implementation with a group of experts of Rijkswaterstaat related to the opportunity and risk management process. According to this session, there is interest for organizing sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. However, these types of sessions are not organized often. The most important aspect mentioned was to support such a

session by a facilitator having more experience with reflecting on principles and objectives. According to this, the solution found for this to increase awareness is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks, supported by a facilitator. Furthermore, there is interest for better communication in and across (a portfolio of) projects, but this is currently is limited. The main issue is that there are large differences in interest at different project levels, making aggregation of information difficult. Clearly indicating what information is required could overcome this issue. According to this, the solution found to create consensus and a better information exchange is an opportunity and risk platform including guidelines that specify what information is required and how to aggregate and present this information.

Finally, the redesign was developed. Since many arguments were given for integrating risk management and value management, elements of both processes are aligned and serve as a base for the redesign of the opportunity and risk management process. Additionally, organizing sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks was integrated in several steps, as it is found important to be aware of what the opportunities and risks really mean. Moreover, decisions made during the project should be in line with the principles and objectives. According to literature, a responsible person should guide and report the integration of these two processes on a regular basis. The results of this study similarly show that a facilitator is required to reflect on principles and objectives in order to increase awareness. Therefore, these two aspects are combined in the redesign resulting in a facilitator guiding the integration of the two processes, and also reflecting on principles and objectives. Due to this, the connection between risk management and value management was strengthened even more. After all, regularly reflecting on principles and objectives with the guidance of a facilitator increases the awareness of the concept behind risk management and value management, allowing them to integrate more effectively. Furthermore, an opportunity and risk platform was integrated into the design. The results argue that this platform could create a connection in and across (a portfolio of) projects. Specifically, this platform supports identification, definition, assignment and assessment of opportunities and risks, and should lead to more control and less rework. To integrate this, guidelines are required specifying what information is required and how to aggregate and present this information. Within projects, these guidelines are clear in general. The problem mainly occurs across (a portfolio of) projects. Thus, this research shows that it is possible to create a connection across (a portfolio of) projects, but that defining guidelines for this appears to be difficult and so the main focus. All in all, this study shows that value management principles were applied to the opportunity and risk management process resulting in increasing value of the process, because solutions were generated to create more awareness, to create consensus and to provide better information exchange.

Table of contents

1. Introduction

1.1. Background

From an investor's point of view, any project involves risks. Especially the construction industry involves activities that carry an even higher level of risks (Burkov, Burkova, Barkhi, & Berlinov, 2018). Various types of risks are associated with project objectives including time, cost, quality, safety and environmental sustainability (Ebrahimnejad, Mousavi, & Mojtahedi, 2008). Despite the innovation and development in construction technologies, delay and cost overrun are still the most crucial challenges in the construction industry, in both developed and developing countries (Abdullah, Alaloul, Liew, & Musarat, 2021). These challenges are caused by tight schedules and limited budgets. Also, the construction industry is one of the most dangerous industries all over the world due to fatalities and accidents recorded per year. Although many countries have established and implemented safety measures for construction, the situation does not seem to improve (Sanni-Anibire, Mahmoud, Hassanain, & Salami, 2020). Besides, unexpected events are currently rather the norm than an exception, making public infrastructure projects highly uncertain and difficult to predict (Floricel, Piperca, & Banik, 2011). For these reasons, the management of risks is of great importance in the construction industry to cope with these uncertainties.

Risk Management (RM) is defined as “a process that allows individual risk events and overall risk to be understood and managed proactively, optimising success by minimising threats and maximising opportunities and outcomes” (APM, n.d.). This suggests that, beside risks, opportunities are taken into account as well. Focusing on the positive side of risk management is also known as opportunity management (OM), which is used for identifying potential benefits in a project (Browning, 2019). In the project management literature, the concept of risk has evolved from one focussing on the likelihood of a negative outcome, to a focus on both negative and positive outcomes (Denney, 2020).

The term risk is defined as the “effect of uncertainty on objectives” (ISO, 2019). RM in construction projects includes dealing with uncertainty and unexpected events (Al-Ajmi & Makinde, 2018). Moreover, projects in the construction industry with high complexity and dynamics are related to high uncertainty and high risk-levels (Lin & Chen, 2021). Therefore, it is important to collaborate as an integrated project team to identify risks as early as possible throughout the project (OCG, 2007). Also, risks are constantly changing and RM is an on-going process throughout the lifecycle of a project. Therefore, the RM strategy should be adaptive in order to deal effectively and quickly with risks when they arise.

The aim of the RM process is to minimize the probability and impact of unwanted events (Hubbard, 2020). This minimization should result in maximization of realization of project objectives. As a result, RM is very important to successfully achieve a project (Lin & Chen, 2021). Furthermore, to make RM successful, it requires commitment, understanding of the process and an active attitude from project team members (OCG, 2007).

However, risk decisions are characterized by great uncertainty and emergence (Aven, 2016). This implies that managing risks highly depends on the situation. According to Sanni-Anibire et al. (2020), opinions are divided about the maturity of numerous methods for risk assessment. On the one hand, Farooq, Thaheem and Arshad (2018) argue that the construction industry even still uses conventional methods of risk assessment. On the other hand, Sanni-Anibire et al. (2020) argue that risk assessment methods have been improved further into more hybrid and unique forms, tailored to specific applications and industries.

For this study, a case study has been performed at Rijkswaterstaat. Rijkswaterstaat is the executive agency of the Dutch Ministry of Infrastructure and Water Management. They are responsible for the

design, construction, maintenance and management of infrastructure facilities in the Netherlands (Ministerie van Infrastructuur en Waterstaat, 2021). As a publicly funded organization, they have the responsibility to justify and clarify the management of their projects. These should run according to plan, scope and within budget. These project-controlling aspects contribute to the overall operational objectives of Rijkswaterstaat. One of the areas of expertise within project management is opportunity and risk management (ORM). Beside risk management, Rijkswaterstaat currently has integrated opportunity management in their processes. Rijkswaterstaat was chosen for this case study because they encounter similar problems with regard to risk assessment as demonstrated in literature. In the current situation, processes at Rijkswaterstaat require quantitative analyses of opportunities and risks. This means that quantitative data are being used as input for probabilistic time and cost estimates, improving project control. A quantitative approach has several benefits, such as monitoring the project progress, comparing projects to each other, and its application in contract negotiations. The current approach for RM seems to work well for a significant part of risks (Vorgers, 2020). However, Rijkswaterstaat experiences a loss of value due to too much focus on quantifying opportunities and risks. On the other hand, qualitative assessment like talking about uncertainty and trying to understand opportunities and risks are actually considered to be valuable, but these are performed too infrequently. Therefore, Rijkswaterstaat encounters problems with the assessment of opportunities and risks. Moreover, Rijkswaterstaat has no view on how to increase value of the ORM process. According to this, the scope was broadened and the entire ORM process was studied.

1.2. Problem statement

Based on the introduction, the problem statement is defined as follows:

"In addition to having problems with assessing opportunities and risks, Rijkswaterstaat has no view on how to increase value of the opportunity and risk management process."

1.3. Literature study

The problem statement suggests that there is no view on how to increase value of the ORM process. Therefore, literature about risks, opportunities and value concepts were being reviewed to understand and apply these concepts.

1.3.1. Risk management

A standard RM study according to (OCG, 2007) is described as follows. In the *first* step the goal and approach for managing risks and seizing opportunities are determined. This step is important for managing time, money and quality, for supporting contracts and quality management, and for identifying and taking advantage of opportunities.

The *second* step identifies opportunities and risks using several methods, assigns it to an owner and defines them explicitly. This results in a list of opportunities and risks related to a particular project. Accurate risks identification is necessary for successful RM and its quality highly depends on the project manager's experience (Kishan, Bhatt, & Bhavsar, 2014). Identifying risks is often performed in a workshop supported by a checklist of common risks (OCG, 2007).

The *third* step analyses opportunities and risks, including risk assessment. For risk assessment, the likelihood of occurrence and potential impact of the identified opportunities and risks are determined. A distinction is made between quantitative assessment and qualitative assessment. Quantitative assessment involves quantifying the impact in terms of e.g. costs, time or performance. Qualitative assessment involves describing and understanding each risk. A descriptive statement of the relevant information of a risk should include e.g. when it could occur, how it could occur, the effect after occurring and its likelihood of occurring (OCG, 2007).

The *fourth* step is about responding to opportunities and risks. It includes an explanation of how to deal with these opportunities and risks. There are several ways to respond to risks. The most common responses are to avoid, transfer, mitigate, share or accept the risk (Kishan et al., 2014).

The *fifth* step evaluates opportunities and risks, meaning they will be adapted, realized or closed. That being the case, stakeholders should be encouraged to evaluate on how well risks have been managed and how to improve (OCG, 2007). Also, opportunities and risks should be monitored constantly throughout the lifecycle of a project in order to update and control them.
The *sixth* and last step analyses and reports the opportunities and risks. The process for seizing opportunities and managing risks of construction and maintenance projects of Rijkswaterstaat follows these six steps too.

1.3.2. Opportunity management

As stated, OM is used for identifying potential benefits in a project (Browning, 2019). Since opportunities are also based on uncertainty, they are closely related to risks. The main difference between opportunities and risks is that opportunities have positive implications of uncertainty while risks have negative implications of uncertainty (Hubbard, 2020). Mentions of OM are increasing in literature and firms' methodologies (Ward & Chapman, 2011). However, according to Olsson (2007), there is still insufficient emphasis on OM in many projects. One reason for this insufficient emphasis could be that project managers receive relatively less credit for exceeding expectations than for meeting them. Another reason could be that project managers are trained to avoid failure rather than illuminate opportunities (de Neufville, 2004). Also, the negative effects that projects may experience if risks are not managed are easier to imagine than the added value for projects that will be lost if opportunities are not taken. This is unfortunate because projects can realize large increases in value if opportunities are utilized (Browning, 2014). These opportunities lead to e.g. cost savings, timesaving, innovation, sustainability or collaboration. They can possibly promote quality, safety or living environment. Involving opportunities contributes to a further step in how to deal with uncertainties. A possible threshold should not automatically lead to not taking advantage of an opportunity, but a trade-off should be made. Browning states "opportunities are uncertain outcomes that would increase a project's value if they happened — the "upside" of uncertainty." (p. 590).

1.3.3. Value management

Value Management (VM) is defined as "a systematic and structured approach for improving projects, products, processes, services and organizations. VM is used to analyse and improve manufacturing products and processes, design and construction projects, business and administrative processes, and both public and private sector services and organizations" (SAVE International, n.d.). According to Dallas (2006), VM is a methodology improving the value of systems identifying the most efficient way to accomplish functions that meet the performance expectations of the client and other relevant stakeholders (Dallas, 2006).
The meaning of value in the broadest sense is the benefit to the client. Value could also be seen as the optimal balance of benefit in relation to cost and risk (OCG, 2007). Another concept states that value is the ratio between the satisfaction of needs and the use of resources. This ratio is presented in Equation 1, in which the symbol 'α' means 'is proportional to'.

$$\text{Value} \ \alpha \ \frac{\text{Satisfaction of needs}}{\text{Use of resources}} \quad (1)$$

(Dallas, 2006)

A standard VM process follows a standard job plan divided into the *Information phase*, *Function analysis phase*, *Creative phase*, *Evaluation phase*, *Development phase*, and *Presentation phase* (Hwang, Zhao, & Ong, 2015). Principles of VM are to strengthen value orientation, apply value thinking, apply a holistic structured approach and to manage complexity, uncertainty and risks (Key Principles, 2020). The last aspect indicates a strong relationship between RM and VM.
VM provides a structured approach to the development and assessment of a project to increase the likelihood of achieving requirements optimally (OCG, 2007). VM is helpful as it supports stakeholders to define and achieve their needs with workshops encouraging team working and participation. The

focus of VM is on the relation between functionality and costs. Although all projects encounter unnecessary costs, only cutting costs without analysing functionality could reduce value too. Cutting costs should only be performed if the functionality and quality are preserved, because otherwise value decreases. VM also supports crucial decision-making and provides a means to define projects clearly and supports innovative solutions. The aim of VM is maximizing the overall performance of the organization by maximising the delivery of the benefits, while minimising the use of resources (OCG, 2007). Furthermore, VM has been recognized as one of the most effective techniques to achieve the best value-for-money in construction projects (Shen & Liu, 2003).

1.3.4. Value management and risk management

The first principle of RM is that it creates and protects value (ISO, 2019; Kishan et al., 2014). Additionally, uncertainties could counteract the preservation of value (Browning, 2014). This means that risks and value are strongly related and interdependent.

VM and RM share similar characteristics too. *First*, both involve multidisciplinary teams in creative workshops. More specific, VM requires creative ideas that fulfil the project functions, while RM requires creativity in risk identification and responding (Hwang et al., 2015). *Second*, both techniques are strongly related to project objectives. VM aims to fulfil functions effectively in relation to project quality and cost, whereas RM attempts to assure the achievement of project objectives. *Third*, VM and RM seem to be both compatible and complementary (Hwang et al., 2015). RM can be improved using the VM team to critically produce or review the RM plan in order to discover alternative ways to identify and manage risks in the creative phase.

Also, Willumsen, Oehmen, Stingl and Geraldi (2019) argue that two aspects determine the perception of how project RM adds value. The *first* is the perception of the content, which is the perception of value. The *second* aspect is the perception of the process' effectiveness for that value. Importantly, both are strongly influenced by context.

According to Hwang et al. (2015) and OCG (2007), RM and VM are interrelated tasks that should be carried out in parallel. These processes are fundamental to successfully execute projects and should be used throughout the life of the project. The project team performs parallel exercises of defining value and associated risks until finding the optimum balance for value and risk.

Dallas (2006) also proposes to integrate VM and RM. To optimise the value of a project it is believed that it is essential to actively manage both value and risk. According to Dallas (2006, p. 53), "it is common practice to treat value and RM as different processes and many publications make this distinction". Although these processes may differ in detail, there is large overlap suggesting an integrated approach.

Othman (2005) states that increasing value could not be achieved unless associated risks are managed. Furthermore, there are several benefits for the integration of different management systems. These benefits include maximizing efficiency, saving time and resources, facilitating information flows and improving decision-making (Alaqad, Gidado, & Piroozfar, 2015).

1.4. Research objective and scope

The research objective is defined as follows:

"Redesign the opportunity and risk management process for infrastructure projects by applying value management principles."

For this study, VM principles were applied in two ways to increase value of the ORM process. First, VM principles were applied as part of the methodology, meaning that certain aspects of the VM methodology are used for the methodology of this study. Second, VM principles were integrated in the redesign. The application of these principles has been described in the methodology. With regard to the scope, this study takes into account the complete ORM process for all types of infrastructure projects.

1.5. Research questions

Following from the research problem and objective, the main research question has been formulated, along with four sub questions. These questions are:

How can value management principles be applied to the opportunity and risk management process for infrastructure projects?

I. *What are aspects in the opportunity and risk management process for infrastructure projects to increase value of?*
II. *What proposals potentially increase value of the opportunity and risk management process for infrastructure projects?*
III. *What are solutions to increase value of the opportunity and risk management process for infrastructure projects after considering implementation issues?*
IV. *How can the opportunity and risk management process for infrastructure projects be redesigned using value management principles?*

2. Research methodology

This study aims to gain insight into the value of the ORM process of Rijkswaterstaat and how value of this process could be increased. Since there is limited empirical research on this topic, the chosen research approach is both explorative and qualitative (Bluhm, Harman, Lee, & Mitchell, 2010). In order to do so, VM principles have been used as part of the methodology. The methodology follows four phases that correspond with the numbering of the research questions. After several phases of data collection the data was analysed before the following phase of data collection could start because it served as input. The complete procedure of the methodology is presented in Figure 1 and will be elaborated in detail.

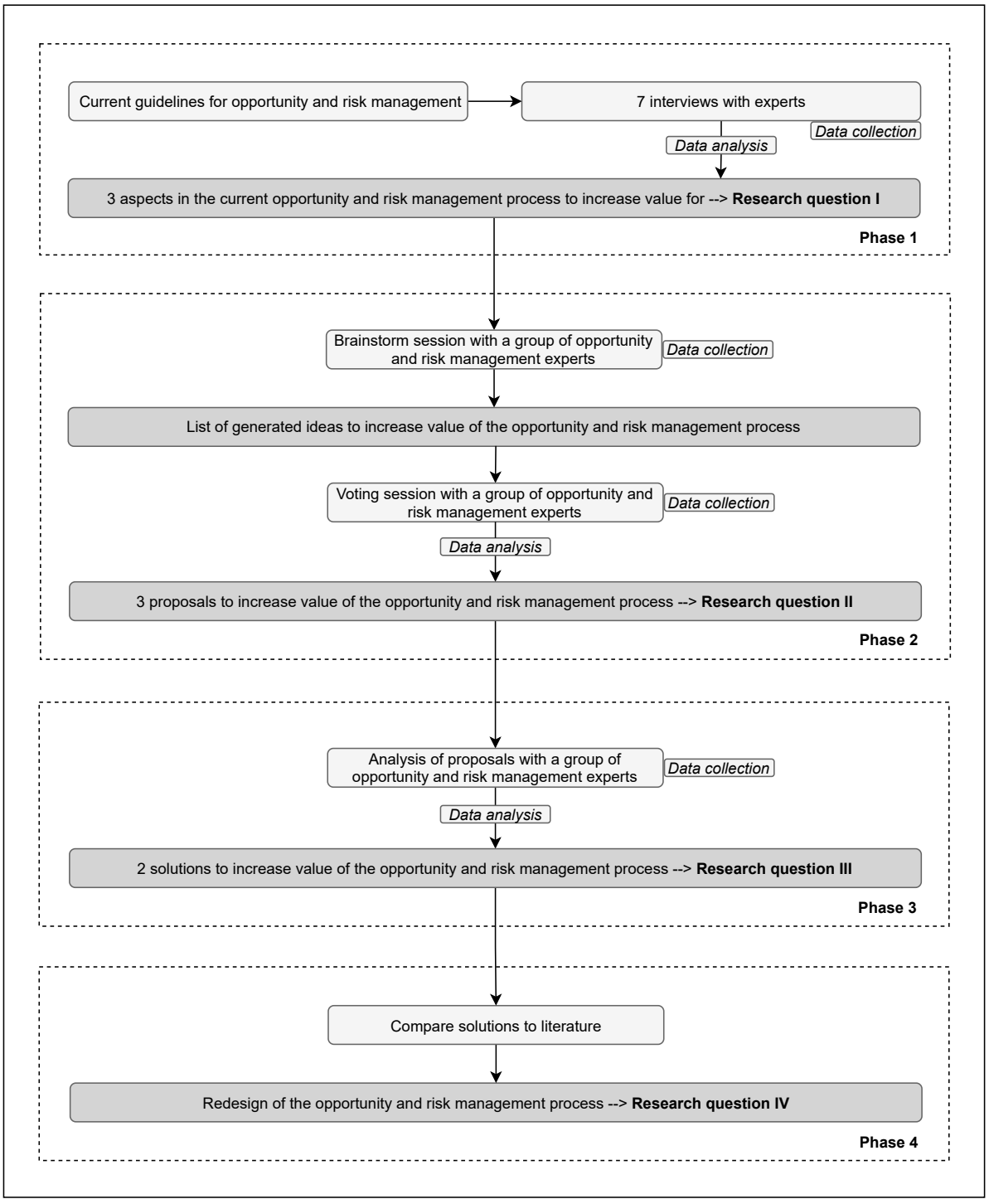

Figure 1 Schematic visualization of the research methodology

2.1. Aspects to increase value of (Phase 1)

The aim of this phase is to determine aspects in the current ORM process to increase value of. To determine these aspects, a VM principle was used. During the *function analysis phase* of a standard VM process, the goal is to organize functions and to analyse where resources like time and money are going (SAVE International, n.d.). Therefore, the aim of the *function analysis phase* is to analyse the current situation, and to divide it into several parts. This principle was used because the ORM process was analysed and divided into aspects for which value could be increased.

In order to perform this phase, the current guidelines for ORM at Rijkswaterstaat were analysed first to understand the state of art. After this, seven interviews were conducted with experts from Rijkswaterstaat. All interviews were conducted using a digital platform and lasted approximately 30 minutes, except for one that lasted 80 minutes. The selection of interviewees was varied in order to analyse different perspectives on the ORM process. Interview data is presented in Table 1, also showing this variety.

Interviewee nr.	Function	Interview date
1.	Cost expert	May 4, 2021
2.	Opportunity management expert	May 4, 2021
3.	Advisor project management	May 6, 2021
4.	Project manager	May 6, 2021
5.	Opportunity and risk management expert	May 10, 2021
6.	Risk management expert	May 10, 2021
7.	Project control manager	May 12, 2021

Table 1 Interview data

In qualitative research detailed answers are preferred and it is even possible to deviate from the original questions to deepen on several aspects that the interviewee emphasizes (Bryman, 2012). Semi-structured interviews were chosen because this method of data collection is appropriate in the exploratory phase of this research. An interview guide has been generated that was used for all interviews. This interview guide is based on principles from the book *Social Research Methods* by Bryman (2012), and is presented in Appendix A. This interview guide includes questions about the interviewees' function, their view on the ORM process and its relation to higher project levels in the organization.

The data obtained from the interviews was analysed before the second phase of data collection because the data served as input for this phase. In order to do so, all interviews were recorded and transcribed. Afterwards, the interview transcripts were analysed. The first step of coding was the process of *open coding*, which means that all interview transcripts were reviewed line by line and codes were assigned to parts of the transcripts in order to determine main themes (Bryman, 2012). The second step of this process was *axial coding*. In this step, previously identified codes are compared, after which similar codes were merged into overarching codes (Bryman, 2012). Finally, these overarching codes were structured to interpret the findings, leading to aspects in the ORM process for which value could be increased. Based on this, a schematic visualization of the coding process is illustrated in Figure 2. This phase answers *research question I*. Furthermore, the aspects to be determined are used as input for Phase 2.

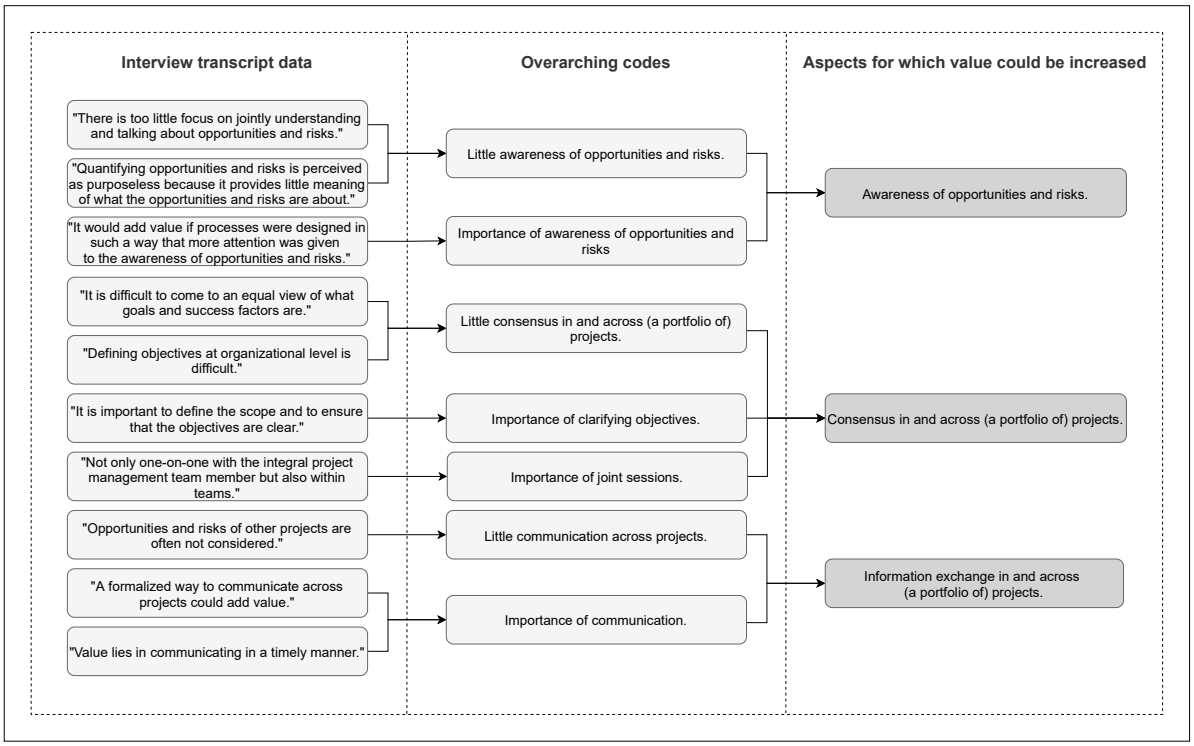

Figure 2 Schematic visualization of the coding process

2.2. Proposals to increase value (Phase 2)

In the second phase, ideas were generated for low valuable aspects of the ORM process that were determined in Phase 1. SAVE International (n.d.) states that in the creative phase of a standard VM process, ideas are generated in all possible ways to accomplish the required functions. Specifically, three aspects to increase value of were selected. For these aspects, ideas to increase value were generated. According to Dallas (2006), the most common method to generate ideas is performing a brainstorming session. Therefore, a brainstorm session was organized with a group of ORM experts to come up with a list of ideas that potentially increase value of the ORM process.

The brainstorm session lasted 15 minutes and was performed with a group of sixteen experts of Rijkswaterstaat in the field of ORM. Since there were three aspects to generate ideas for, the participants were divided into three groups based on the first letter of their surname. Each group started with a different aspect so that in case of limited time, ideas were equally spread across the aspects approximately. The session took place on a digital platform called Padlet. An impression of this software including some ideas is presented in Figure 3. In this figure, the three aspects to increase value for are expressed as a question and lined up next to each other. Underneath these questions participants were able to write their ideas including a title, an explanation and their name. Their names were requested to trace persons back in case further explanation is required. However, in Figure 3 their names are censored with regard to privacy regulations.

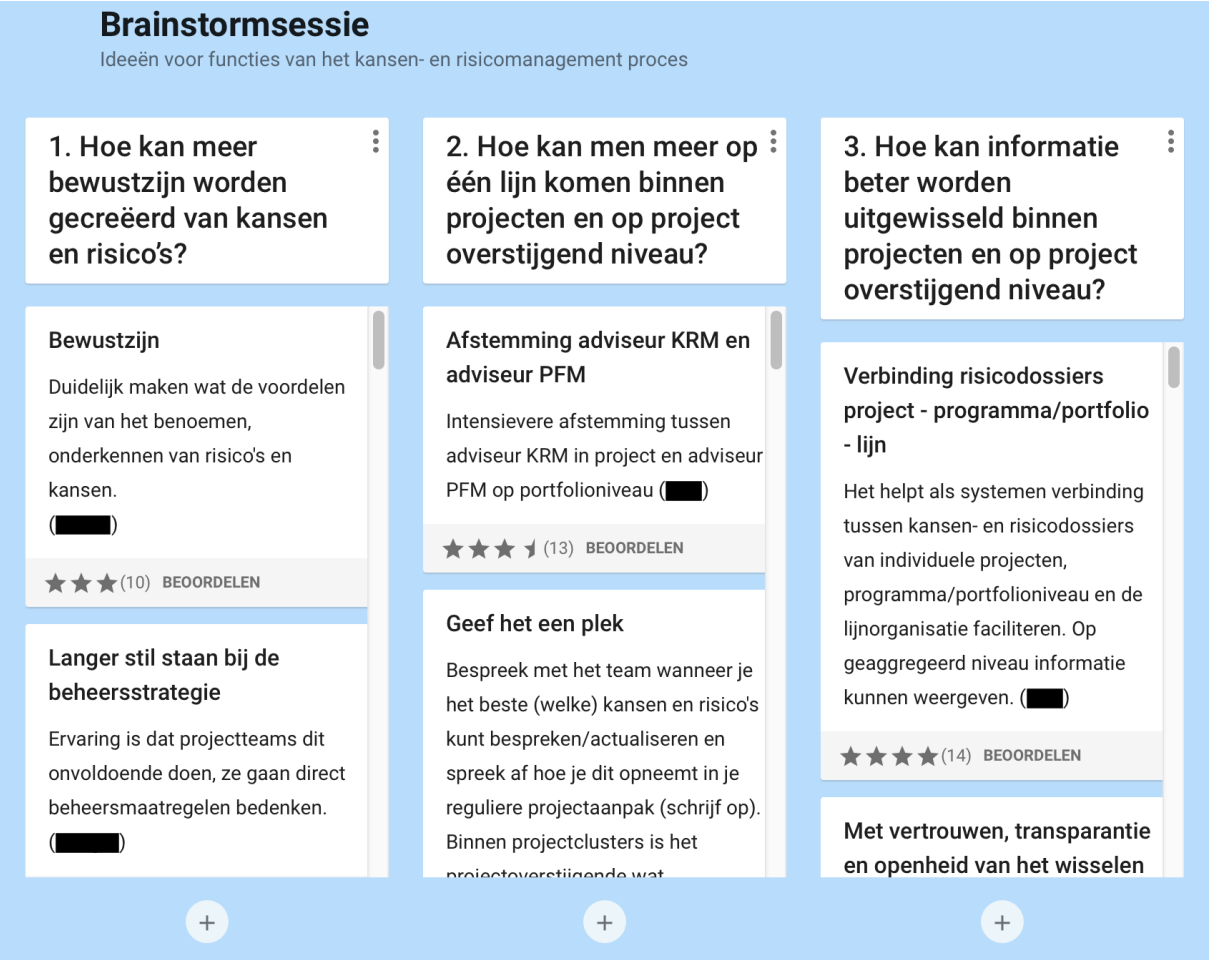

Figure 3 Impression of experts' conceived ideas and ratings in Padlet

After the brainstorm session, the ideas that were initiated were evaluated. SAVE International (n.d.) states that the evaluation phase in a standard VM process selects ideas that are feasible for development. This principle was used here because ideas were evaluated based on a voting session. This voting session lasted 15 minutes and was also performed with a group of sixteen experts of Rijkswaterstaat in the field of ORM. However, they were not the exact same experts as in the brainstorm session. Namely, 4 participants of the brainstorm session did not participate, and 4 other experts of Rijkswaterstaat in the field of ORM participated to this session. Just as for the brainstorm session, Padlet was used for the voting session. For consistency, the same online document with ideas from the brainstorm session was provided. In this document, participants rated ideas individually using a scale of 1 to 5 stars, with more stars meaning more value. This option is built into the software of Padlet and is also visible in Figure 3. Again, participants were divided into groups based on the first letter of their surname and each starting with rating a different aspect, so that each idea received approximately an equal number of votes in case of limited time. Accordingly, Padlet shows the amount of votes each idea received and the average amount of stars. The ideas and their ratings were analysed to determine which ones are potential solutions. In order to do so, the ideas with the highest ratings were analysed first. Furthermore, ideas with a second highest rating were considered. This is because ideas with a second highest rating could also be potential solutions when they support the highest rated ideas. Per aspect, 2 to 4 ideas were selected and combined to a single proposal. Three proposals, one for each aspect, were generated as input for Phase 3. This phase answers *research question II*.

2.3. Solutions to increase value including implementation issues (Phase 3)

In the third phase, the three proposals were discussed. Specifically, this phase further analyses and develops the proposals and checks how they can be implemented. During the development phase in a standard VM process, potential ideas are further analysed and developed into specific solutions (SAVE International, n.d.). The three proposals were discussed with a group of 5 experts during 1 hour. For each idea, four questions were main input for the discussion. These questions were: "What would this idea exactly look like?", "Is this idea already implemented to some extent?", "What needs to be done for implementation?" and "Are there any problems with implementation?".

In order to analyse the data obtained from the analysis session, it was recorded and transcribed. Just like the interviews, the transcript of this session was analysed according to the same coding process and highlights were selected. This phase answers *research question III*. Based on these highlights, the proposals were transferred into more specific solutions, to integrate in the redesign.

2.4. Redesign of the opportunity and risk management process (Phase 4)

During the fourth phase the redesign was generated. First, the solutions from Phase 3 were compared to literature. This should determine whether these solutions already exist and if so, what are advantages, disadvantages and possible implementation issues. Furthermore, an analysis was performed to check whether VM principles could also be integrated into the ORM process in order to increase value of this process. In order to check how RM and VM could be integrated, literature about these concepts was reviewed using online literature databases. Keywords like "value management", "risk management", "construction industry" and "integration" were used to find articles describing similarities between RM and VM and how they could be integrated. The result of this phase is a redesign of the ORM process and answers *research question IV*.

3. Results

3.1. Aspects to increase value of (Phase 1)

To answer *research question I*, three aspects were determined to increase value of, based on several interviews. After performing the coding process, presented in Figure 2, connections between interview transcript data became clear. The aspects to increase value of are 'awareness of opportunities and risks', 'consensus in and across (a portfolio of) projects' and 'information exchange in and across (a portfolio of) projects'.

3.1.1. Awareness of opportunities and risks

According to several interviewees, there is little awareness of opportunities and risks. When quantifying opportunities and risks, the overall experience is that the focus is too much on determining the value of an opportunity or risk, rather than its meaning. As a result, quantifying opportunities and risks often is experienced as purposeless. Also, when determining the most important opportunities and risks, the focus is too much on determining the order of their importance. Interviewee 6 argues that this is caused by the fact that these procedures still happen too much on autopilot to just follow the procedure. This shows that, within the ORM process, there is lacking focus on the understanding of what opportunities and risks really mean. On the other side, the expectation is that taking more time to focus on understanding opportunities and risks, value will increase. To address this, proposals are to talk consciously about opportunities and risks and to not get distracted by the procedure and process. Therefore, increasing awareness of opportunities and risks could increase value, being the first aspect to increase value of.

3.1.2. Consensus in and across (a portfolio of) projects

Based on the interviews, it appears to be difficult to create an equal view within projects of what objectives and success factors are. Across (a portfolio of) projects this is even found more difficult. Due to this, there is little consensus in and across (a portfolio of) projects. However, the importance of clarifying objectives was mentioned several times. Interviewee 3 even argued that it is "essential to generate short and concise objectives for performing opportunity and risk management explicitly". Furthermore, Interviewee 1 emphasised the importance of sessions in which opportunities and risks are discussed jointly. According to this, clarifying objectives and success factors, and organizing more joint sessions both contribute to creating consensus in and across (a portfolio of) projects leading to higher value. More general, creating consensus in and across (a portfolio of) projects could increase value, being the second aspect to increase value of.

3.1.3. Information exchange in and across (a portfolio of) projects

Based on the interviews, it seems that problems affecting several projects are often solved independently. This shows that there is little communication across (a portfolio of) projects. Also, it was implied that communication could be improved within projects. However, interviewees argued that simultaneously addressing problems affecting several projects would increase value. In that case, risks can be compared to risks that already have occurred in other projects in order to find similarities and to put control on this (Interviewee 3). Therefore, a formalized way to communicate across projects is required. Also, communicating in a timely manner could add value. These aspects emphasise the importance of communication. Therefore, improving information exchange in and across (a portfolio of) projects could increase value, being the third aspect to increase value of.

3.2. Proposals to increase value (Phase 2)

For answering *research question II*, three proposals were developed to create more awareness, consensus and better information exchange based on a brainstorm session and a rating session. The results of these sessions are presented in Table 2, Table 3 and Table 4. These tables present the idea number, title, description, rating and number of reviews. However, not all participants wrote down a title. The proposals developed are all presented in Figure 4, including the connection with the previous and following phase.

3.2.1. Ideas for awareness of opportunities and risks

In order to create more awareness of opportunities and risks, a total of fifteen ideas were conceived. These are presented in Table 2, from which idea number 1 received the highest rating. It states that "more moments of reflection in teams on the principles and objectives of the project" can contribute to greater awareness of opportunities and risks. Furthermore, four other ideas (number 2, 3, 4 and 5) received the second highest rating. Out of these four, idea number 3 is in line with previous mentioned idea and states: "take your time and evaluate regularly". Therefore, according to the participants, the best way to create more awareness is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. This is presented as Proposal 1 in Figure 4.

Idea nr.	**Title of idea**	**Idea description**	**Rating (number of reviews)**
1.	“Reflecting more frequently on the project's objective”	“More moments of reflection in teams on the principles and objectives of the project.”	4,5 (14)
2.	-	“Starting at the beginning with opportunities so that teams see the added value.”	4 (11)
3.	-	“Sharing successes and appealing examples online.”	4 (12)
4.	“Attention”	“Put it on the agenda, take time for it and let it return regularly. Evaluate regularly and also discuss what you have achieved and what you want to do differently. Integral project management team has an example role with translation to the sub-teams. The project manager should discuss it with portfolio manager and give feedback to the team.”	4 (13)
5.	“Systems thinking vs. soft side”	“From the cadastre I got an eye-opener, namely that the system thinking (process) is actually made too important so that the eye for the dialogue and soft side is lost. And so, the conversation about risks no longer catches on with the target group (uniform-one size fits all) but as a result the attention and added value of risk management is no longer felt. So make sure you have an appropriate risk management method per target group: executive team, management team, projects.”	4 (13)
6.	“More focus on management strategy”	“The experience is that project teams do not do this enough; they immediately start coming up with management measures.”	3,5 (13)
7.	-	“Getting the objective of the project clear. Engage in conversation about opportunities and risk management (not a checklist).”	3,5 (13)
8.	“Role of integral project management members”	“Active role of integral project management members in the process.”	3,5 (13)
9.	“Risk Appetite”	“Discussion of what risks one is willing to take with scenarios for action if things do go wrong.”	3,5 (11)
10.	“Awareness”	“Clarifying the benefits of naming and recognizing risks and opportunities.”	3 (10)
11.	“Ensuring clear (cascading) goals”	“The project organization has to deal with various objectives sometimes resulting in a lack of focus. In addition, some topics remain 'floating'. For example, think about sustainability. However, at the same time the organization has to downsize. What does this mean for project teams?”	3 (12)
12.	-	“Employing Ambassadors.”	3 (11)
13.	-	“Focusing on the 'why' of exploiting opportunities and managing risks (showcasing added value). Indeed, many role holders unfortunately see	3 (12)

		opportunity and risk management as a 'must do'."	
14.	"Control"	"You can only control risks and uncertainties when the risks are known. Even when control may not be possible, then it is important for others in the chain to know this."	2,5 (11)
15.	-	"Connect with the team's activities, read pieces, ask questions"	2,5 (12)

Table 2 Ideas to create more awareness of opportunities and risks

3.2.2. Ideas for consensus in and across (a portfolio of) projects

In order to create consensus in and across (a portfolio of) projects, a total of sixteen ideas were conceived. These are presented in Table 3. Three of those received the highest rating, from which ideas number 1 and number 2 are in the same line. Idea number 1 is that "analysis of themes across teams" can help to achieve consensus. In line with this, idea number 2 is about "rolling out the strategy at the organizational level to the project level" and also states that "the involvement of portfolio management can contribute to this". Idea number 3 also receives the highest rating but does not align with previous two ideas. Therefore, this one was not taken into account. Furthermore, one idea with the second highest rating (idea number 4) aligns with this: "intensified coordination between the ORM advisor and the advisor portfolio management". Therefore, according to the participants, the best way to achieve consensus in and across (a portfolio of) projects is to discuss strategies and analyses of opportunity and risk management on organizational level and project level to create a connection, and intensify coordination between the opportunity and risk management advisor and the advisor for portfolio management. This is presented as Proposal 2 in Figure 4.

Idea nr.	**Title of idea**	**Idea description**	**Rating (number of reviews)**
1.	-	"Analysis of themes across teams, address in portfolio management."	4 (13)
2.	"Strategy / engagement portfolio management."	"Roll out organization-level strategy at the project level. The involvement of portfolio management can contribute to this."	4 (12)
3.	-	"Include this by default in Project Start Up and Project Follow Up."	4 (13)
4.	"Alignment of opportunity and risk management advisor and portfolio management advisor"	"More intense coordination between opportunity and risk management advisor in project and portfolio management advisor at portfolio level."	3,5 (13)
5.	"Project objectives / Assignment."	"Starting a project seriously involves making goals and mission clear. Many times the technique and execution is started immediately. Yet there is resistance to talk about this. Given the demand, this is important anyway. Isn't the question the main risk of any project?"	3,5 (13)
6.	"Brainstorm with team on MC goals"	"How does the team contribute to the MC goals and what opportunities and risks does the team see."	3,5 (13)
7.	"Recognize impact on project mission"	"Conduct quick inventory to determine if exploitation of opportunities will impact project mission (scope form / POF). For example, accommodating wishes and co-benefits of external stakeholders."	3,5 (14)
8.	"Transcending employees"	"Which officers could work across the board?"	3,5 (13)
9.	"Give it a place"	"Discuss with the team when it is best to discuss and update opportunities and risks, and agree how to incorporate this into your regular project approach (write it down). Within project clusters, the 'cross-project' aspect is a little easier to do. Start by discussing the topic and approach between project clusters."	3 (14)
10.	-	"Seeking connection with portfolio management consultant, also by sharing project and cluster knowledge on opportunities and risks."	3 (12)
11.	"Risk reservation"	"You could decide that the money for risk reserving is managed outside the project, and that outside projects it is decided which team gets 'extra' risk reserving (based on the control of the risks for example)"	3 (14)
12.	-	"Uniform practices (for example, uniform risk management plan for all clusters)"	3 (13)
13.	-	"Create overviews and discuss them with the whole team."	2,5 (13)

14.	-	“Discuss goals and interests with each other on a regular basis.”	2,5 (11)
15.	“Recognizable way of working.”	“The more recognition there is with each other, the easier it is to look at things with each other. Doing uniformity on intakes, for example, or where the exchange can just benefit at an overarching level.”	2,5 (13)
16.	“Know each other.”	“Ignorance of departments and organizational units leads to misunderstanding and therefore to suboptimal cooperation (for example, interface of Programs, Projects and Maintenance / Large Projects and Maintenance and Central Information Provision).”	2,5 (14)

Table 3 Ideas to create consensus in and across (a portfolio of) projects

3.2.3. Ideas for information exchange in and across (a portfolio of) projects

In order to improve the exchange of information in and across (a portfolio of) projects, eighteen ideas were conceived, being presented in Table 4. Most of the ideas concern the exchange of information across (a portfolio of) projects. Of all eighteen ideas, five have received the highest rating from which number 1 and number 2 are about creating connections between projects, and number 3 and number 4 are about the form in which information is presented. These topics do influence each another, because the way information is presented can create connections in and across (a portfolio of) projects. Idea number 2 argues that "presenting information at an aggregated level" could improve information exchange. Idea number 4 states that "simplifying information" could contribute to this. However, idea number 5 also receives the highest rating but does not align with previous four ideas. Therefore, this one was not taken into account. Based on previous four ideas, according to the participants, the best way to exchange information is to aggregate and simplify information to create a connection in and across (a portfolio of) projects. This is presented as Proposal 3 in Figure 4.

Idea nr.	**Title of idea**	**Idea description**	**Rating (number of reviews)**
1.	“Connection in the chain”	“Because different risk management methods are used in the chain, the coordination between the chain partners about risks is not optimal (qualitative vs. quantitative risk management). By providing a risk management advisor function in the region, overarching coordination can be provided so that the projects and the OG can coordinate and use information from each other.”	4 (13)
2.	“Linking risk files of the project program and the portfolio line”	“It helps if systems facilitate the connection between opportunity and risk files of individual projects, program/portfolio level and the line organization. Being able to present information at an aggregate level.”	4 (14)
3.	“Unification”	“Where the information is useful across projects, unify it and make it recognisable.”	4 (11)
4.	“Simplify information and reduce it to its essentials”	“Currently, there is so much information about opportunities and risks included in files that it becomes more difficult to exchange it, and for others (than the consultants and Project Control Manager) to understand what it adds. This also makes accumulating information easier.”	4 (10)
5.	“Look at what ideas are already out there”	“Memos have been written and pilots have been run to do analysis from the risk database. The condition is that analysis from the database may be programmed. Don't start over, all the formats are already there”	4 (11)
6.	“Share best practices”	“Make available 'best practices' in order to get additional budgets for this. For example, for initiatives related to sustainability.”	3,5 (12)
7.	-	“Organize ICT (so that it is easier) and make sharing information easier and more interesting (for example, project control trade day or a departmental meeting or pool meeting). Then look beyond 'own' borders.”	3,5 (13)
8.	-	“Keep it alive and act on it. For example, an item on the zoning board.”	3,5 (13)
9.	“Transcending employees”	“Which officers could work across the board?”	3,5 (11)
10.	“Link between dossiers between projects”	“Created by top risks from clusters, projects and programmes.”	3,5 (9)
11.	-	“Engaging with other disciplines and jointly discussing where and how to	3,5 (10)

		best manage risks."	
12.	"Comparability"	"Start with the same format and periodically discuss whether you have used it the same, make follow-up agreements. Agree whether the contacts are made by discipline or who performs it."	3,5 (9)
13.	-	"With trust, transparency and openness of exchanging the data/information."	3 (12)
14.	"Unambiguous working method"	"By following an unambiguous working method. Facilitating moments of exchange."	3 (11)
15.	-	"Sharing successes online, presentations to other teams, trade days. Communication is exchanging, learning, sharing and enthusing."	3 (13)
16.	"Accessible database"	"The risk database needs to be organized and fields need to be filled in unambiguously to make good analyses."	2,5 (13)
17.	-	"Kind of an information platform."	2,5 (12)
18.	"Circulation"	"Permanent travelling "circus" with good examples, questions and answers on a platform. A place where connection is made."	2,5 (10)

Table 4 Ideas to improve the exchange of information in and across (a portfolio of) projects

3.3. Solutions to increase value including implementation issues (Phase 3)

For answering *research question III*, two solutions were developed to increase awareness, create consensus and provide better information exchange based on an analysis with a group of ORM experts. This analysis was mainly about implementation issues and the highlights are presented in Appendix B. The first solution is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks, supported by a facilitator. The second solution is an opportunity and risk platform including guidelines that specify what information is required and how to aggregate and present this information.

3.3.1. Analysis of Proposal 1

The first proposal (to create more awareness of opportunities and risks) that was analysed is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. There is a strong connection between these two aspects. One respondent supports this and argued: "the more often you reflect on objectives, the more actively you engage with risks threatening these goals and with opportunities to make objectives easier to achieve". With regard to the proposal, currently these sessions are not organized often. One reason for this is that principles and objectives usually come from the department quality management because they have more time for these sessions. However, there is enthusiasm for this proposal because it could potentially increase value. When organizing such a session, a facilitator should guide this, as clarifying principles and objectives is still found difficult according to one respondent. According to the respondents, a person having more experience with reflecting on principles and objectives should facilitate this session in which the project management team reflects on principles and objectives, and its relation to opportunities and risks. From this analysis, Solution 1 was created. This solution argues to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks, supported by a facilitator. Figure 4 presents how this solution is related to previous phases.

3.3.2. Analysis of Proposal 2 and Proposal 3

The second proposal (to create consensus in and across (a portfolio of) projects) that was analysed is to discuss strategies and analyses of opportunity and risk management on organizational level and project level to create a connection, and intensify coordination between the opportunity and risk management advisor and the advisor for portfolio management. This connection between projects and organizational level increases value in two directions. Namely, for projects it helps to know that the organization is involved with problems of projects, and for the organization it helps to know that several projects do have similar problems. According to this, the proposal mainly focuses on consensus across (a portfolio of) projects rather than consensus within projects. However, there are differences in interest between project level and organizational level. For that reason, intensified

coordination between the ORM advisor and the advisor portfolio management is not found to be a solution according to all respondents.

The third proposal (to better exchange information in and across (a portfolio of) projects) connects to this in many ways. This proposal is to aggregate and simplify information to create a connection in and across (a portfolio of) projects. Therefore, it is also about the connection between project level and the organizational level. Currently there is a platform for opportunities and risks that supports the connection between project level and organizational level. However, there are some issues. First, each project has its own risk file in which a lot of information is stored but other projects do not use this often. Second, there are some ICT systems suitable for this, but there are no strict guidelines indicating what information is required and how that information should be provided. It is found difficult to extract connections between different projects and to determine how information about opportunities, risks and objectives can be aggregated.

Because Proposal 2 and Proposal 3 are both about the connection between project level and the organizational level, they are combined to one solution, called Solution 2. This solution is an opportunity and risk platform including guidelines that specify what information is required and how to aggregate and present this information. Figure 4 presents how this solution is related to previous phases.

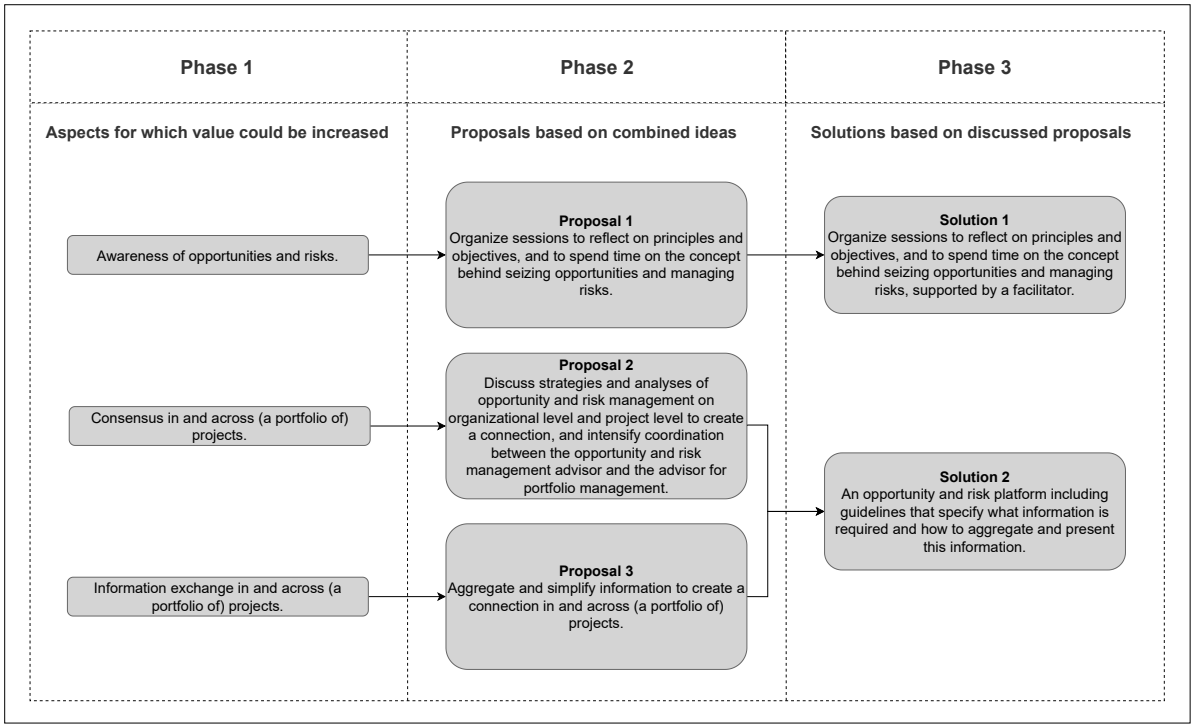

Figure 4 Schematic visualisation of summarized results of Phase 1, Phase 2 and Phase 3

3.4. Redesign of the opportunity and risk management process (Phase 4)

This section describes the development of a redesign for the ORM process. A schematic visualization of this redesign is presented in Figure 5 consisting of seven steps. These steps were created based on four different design aspects. These are also presented in Figure 5 each having a different colour. The shaded parts within the steps are based on the design aspects with corresponding colours. All aspects en steps are elaborated in this section.

3.4.1. Design aspects for the redesign of the opportunity and risk management process

Aspect 1 consists of elements of a standard ORM process. *Aspect 2* consists of elements of a standard VM process. For both aspects, the elements are based on the results of the literature study. In addition, because of many arguments for the integration of RM and VM described in the literature study, this is applied in the redesign as well. Specifically, this integration of RM and VM is mainly based on Dallas (2006). The integration of OM is not mentioned in literature. However, OM was integrated too because this is already part of the process of Rijkswaterstaat. How the different elements from these aspects are integrated is explained within the seven steps.

Aspect 3 is based on Solution 1, which is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks, supported by a facilitator. This solution should increase awareness of opportunities and risks. Yirenkyi-Fianko & Chileshe (2015, p. 254) state: "lack of awareness of risk management processes is one of the major barriers to the usage of risk management processes." This implies that it is found important to increase awareness of opportunities and risks among people. Furthermore, the use of a facilitator was proposed in the results as a precondition to support such a session. Alaqad et al. (2015) argue that there is a need for a facilitator to organize and support the integration at even more stages of the project. Namely, performing workshops of two methods simultaneously might not always be beneficial because this can result in losing the purpose or focus (Alaqad et al., 2015). Furthermore, Dallas (2006) adds to review and report the progress of implementation and management actions by a responsible person on a regular basis. For these reasons, a facilitator is required to reflect on principles and objectives, and to guide the integration of processes.

Aspect 4 is based on Solution 2, which is an opportunity and risk platform including guidelines that specify what information is required and how to aggregate and present this information. This solution should create consensus and better information exchange. According to Moshtaghian, Golabchi, & Noorzai (2020), an opportunity and risk platform has a positive effect on projects because this provides more control on time that may result is less rework. Moshtaghian et al. (2020) also argue that such a platform could improve risk identification and risk evaluation. Therefore, the use of such a platform is also integrated in the design.

3.4.2. Steps within the redesign of the opportunity and risk management process

In *Step 1*, the objectives, approach and context of the project are determined to achieve a better understanding of the project. Since Dallas (2006) argues that the preparation stage of both the RM and VM process have similarities, they are combined in this first step.
In *Step 2*, a functional analysis is performed. This was separated from other steps because it is a standalone process to perform based on the project objectives, approach and context. A function tree describing the concept in functions should be the result.
Step 3 is about to identify, define, assign and assess opportunities and risks. The proposed platform for opportunities and risks (Solution 2) could support this because many opportunities and risks that already have been encountered in other projects are saved on this platform. It then serves as a source of inspiration when identifying opportunities and risks, and as a guide for defining, assigning and assessing opportunities and risks. Furthermore, according to Solution 1 it is found important to regularly reflect on principles and objectives to create more awareness of opportunities and risks. Creating this awareness is even more important when assessing opportunities and risks because it is

about understanding what the opportunities and risks really mean. For that reason, in this step a session is organized to reflect on principles and objectives with the aim of supporting the assessment of opportunities and risks. A facilitator guides this session as Solution 1 also describes.
In *Step 4*, ORM and VM are aligned again because for both processes there is a creative element. For RM, ideas are generated how to treat the opportunities and risks being determined in *Step 3*, and for VM, ideas are generated to accomplish the required functions determined in *Step 2*. A brainstorm session supports generating these ideas.
In *Step 5*, the ideas generated in the previous step are evaluated. Specifically, the ideas to treat opportunities and risks, and ideas to accomplish the required functions are clarified, categorized, and selected for development. The coherence between the ideas should be addressed. Furthermore, the ideas selected for development should be in line with the principles and objectives of the project. Therefore, principles and objectives are reflected to check for this alignment.
In *Step 6*, proposals are developed based on the ideas generated in previous step. During development, risk allowance should be monitored and opportunities should be realised. Again, principles and objectives are reflected in order to check whether the proposals satisfy these. This also contributes to selecting the most suitable alternative.
In *Step 7*, the proposals are presented including involved opportunities and risks, being the result of the project. One of the most important things to do after a project is to learn from mistakes made and to report useful information. For that reason, this information is added to the platform for opportunities and risks to support future projects.

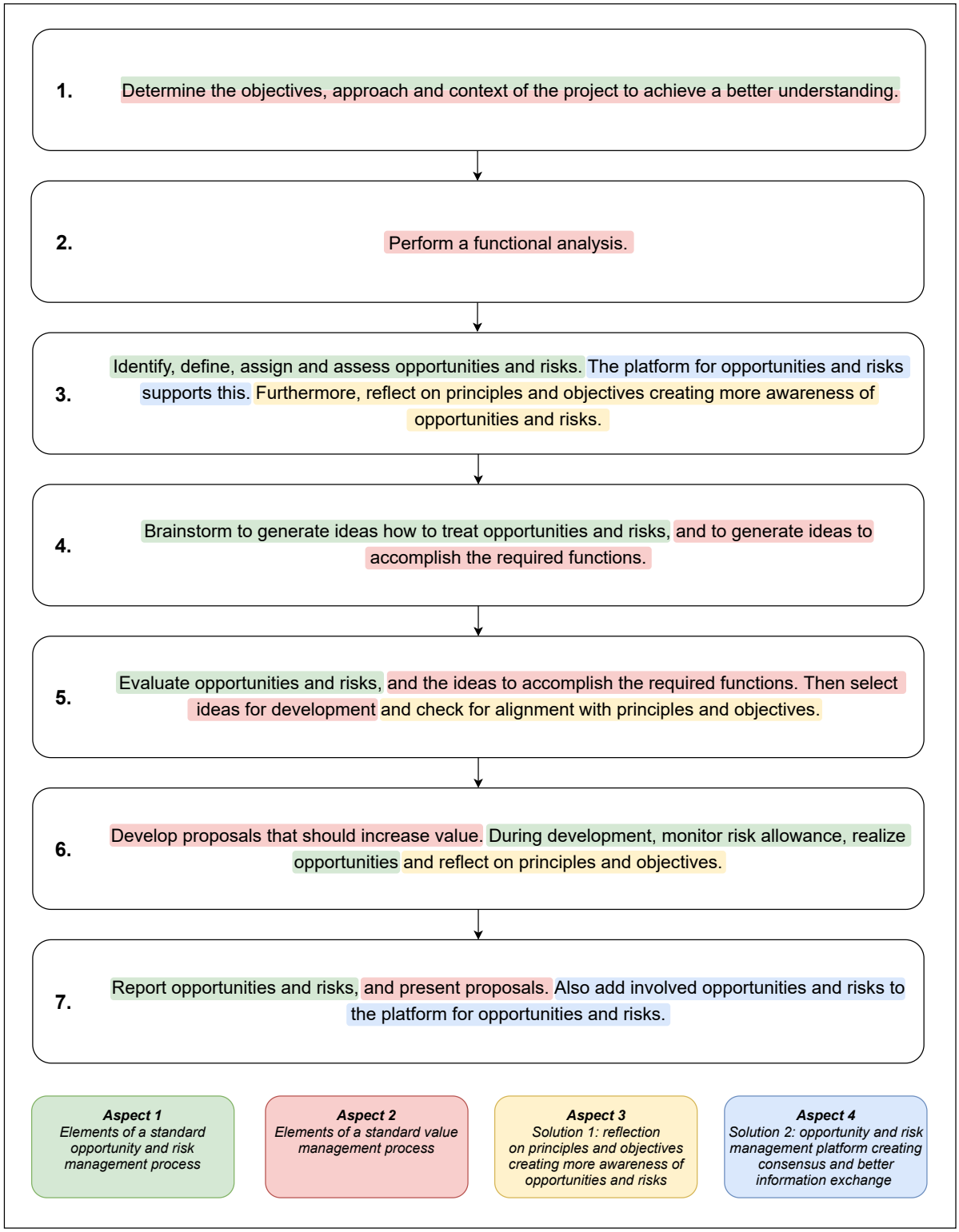

Figure 5 Schematic visualization of the redesign based on Dallas (2006) and previous results

4. Discussion

In this study, VM principles were applied to redesign the ORM process for infrastructure projects. These principles were applied as part of the methodology and several sessions were organized based on these principles. In the interviews, all interviewees are involved differently in the ORM process. However, they made similar statements independently. This means that the aspects mentioned are encountered more than once in different areas of the ORM process, and that all interviewees have a similar view on this process. Also in the other sessions the participants provided similar statements. Based on this, it can be stated that if this study were to be repeated, the results would be similar and according to this, the results of this study are reliable.

The results of this study show that reflecting on principles and objectives with a facilitator could increase awareness of opportunities and risks. This can be explained because reflecting on principles and objectives provides insight in the rationale of the process, resulting in more awareness of the process and involved opportunities and risks. This result is in line with studies from Yirenkyi-Fianko & Chileshe (2015) and Alaqad et al. (2015). They highlight the importance of reflecting on principles and objectives, and the awareness of opportunities and risks. The use of a facilitator was even appointed as a precondition in literature to perform such a session (Dallas, 2006). Additionally, the results of this study show that an opportunity and risk platform could create consensus and a better information exchange. This can be explained because when opportunities and risks can be described uniformly, then a better interpretation of different projects' information could arise, leading to consensus and better information exchange. Moshtaghian et al. (2020) support this because such a platform could improve risk identification and risk evaluation. This shows that these results are in line with existing literature, demonstrating the validity of this study.

Furthermore, several studies claim that the processes of RM and VM can be well integrated. In the redesign of the ORM process, elements of a standard ORM and VM process are integrated based on Dallas (2006). Despite many advantages for this integration, there are also some points for attention. According to Hiley and Paliokostas (2001), one of the largest obstacles for integrating RM and VM is the lack of information about what guidelines and standards practitioners should follow. Furthermore, Alaqad et al. (2015) argue that this integration is complex and requires careful attention to all the details of the project, including its location and budget constraints. Another critical aspect is that all participants in the workshops should be familiar with the methods, techniques and tools used in the integration (Ranesh, Zillante, & Chileshe, 2013). Hiley and Paliokostas (2001) state that different team members with different views are required in order to tackle the problems in more efficient ways. According to these studies, it is strongly recommended to involve a facilitator throughout the complete process to guide the integration of processes. Since the results of this study show that a facilitator is required to reflect on principles and objectives, this result is in agreement with previous studies, demonstrating the validity of this research. Based on this, it is essential to customize the redesign for each particular project, requiring much attention. Nevertheless, this is beneficial for the applicability of the design because it then can be applied to all different types of projects.

However, it must be taken into account that this study is mainly based on the opinions of people within the same organisation. If the same process were to be carried out in another organisation with a different ORM process, the results might be different. For this reason no general statement can be made about whether this redesign is applicable to other organisations. Therefore, the advice for future research is to conduct a similar research in another organisation to find out if a similar design will be generated. Another limitation of this study is that the participants of all sessions were not constantly the same persons. Despite presenting all required information before starting the sessions, this has possibly led to a lack of involvement resulting in not completely understanding the context due to misinterpretations. This possibly influences the reliability. With regard to the

methodology, the research objective is to increase value of the ORM process by implementing VM principles. The VM principles have been applied, but in a different way than a standard VM process. In this study, semi-structured interviews were conducted to determine aspects in the ORM process to increase value of. In the *function analysis phase* of a standard VM process, functions are described to increase value of. According to Dallas (2006), a team will interact and communicate with each another effectively to create a logical diagram that they can all understand and agree with. The difference is that a functional analysis focuses on functional performance not including judgement, while the interviews included judgement of the interviewees. The disadvantage of judgement is that opinions differ; what one person does not find valuable, another may find valuable. In other words, the disadvantage of a judgement is that not everyone may agree with the result, possibly leading to inaccurate results.

There is already existing a type of platform where opportunities and risks are stored that seems to work well within projects. However, it was claimed that the use of such a platform across (a portfolio of) projects is difficult because there are no clear guidelines on how data should be aggregated. To make such a system work, data should be aggregated and presented in a way relations become clear. Also, guidelines should be provided to projects on how to supply their data. This is found difficult because the objectives of projects are different from those of the organization. There is a need for future research on how to exactly aggregate and present data to create a connection across (a portfolio of) projects. Furthermore, the results show that there is interest for sessions in reflect on principles and objectives and to spend time on the concept behind seizing opportunities and managing risks. However, the exact content, the frequency, and the people involved for these sessions are not determined in this research. Future research should address these aspects.

5. Conclusion

The objective of this study was to redesign the ORM process for infrastructure projects by applying VM principles. The main research question connects with the objective, because it questions how these VM principles could be applied. In order to achieve this, interviews and several sessions were organized according to VM principles to collect data. During the interviews, the goal was to determine aspects to increase value of. Based on the interviews; awareness, consensus and information exchange appear to be the most important aspects to increase value of in the ORM process. This answers *research question I*.

For these aspects, three proposals that potentially increase their value were developed based on a brainstorm session and voting session. To increase awareness, the proposal is to organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. To create consensus, the proposal is to discuss strategies and analyses of ORM on organizational level and project level to create a connection, and intensify coordination between the opportunity and risk management advisor and the advisor for portfolio management. To provide a better information exchange, the proposal is to aggregate and simplify information to create a connection in and across (a portfolio of) projects. This answers *research question II*.

According to the analysis session, there is interest for organizing sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks. However, these types of sessions are not organized often due to practical reasons. First, limited time is scheduled for these types of sessions. Second, clarifying principles and objectives is still found difficult. For this, it was proposed to support such a session by a facilitator having more experience with reflecting on principles and objectives. According to this, the solution found is to organize sessions in order to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks, supported by a facilitator. For the second and third proposal, similar comments were given. Namely, strategies and analyses result in a need for information that can be fulfilled by information exchange. Moreover, both concepts concern the relationship between individual projects and the organization. The results imply that communication within projects seems to work well, but communication in and across (a portfolio of) projects is currently is limited. The main issue is that there are large differences in interest at different project levels, making the aggregation of information difficult. Clearly indicating what information is required could overcome this issue. According to this, the solution found to create consensus and a better information exchange is an opportunity and risk platform including guidelines that specify what information is required and how to aggregate and present this information. This answers *research question III*.

To generate the redesign of the ORM process, elements of a standard RM and VM process are integrated mainly based on Dallas (2006). Several other studies also claim that the processes of RM and VM could be integrated well. Specifically, the preparation of both the RM and VM process are combined because of many similarities. Also, both processes include a creative element that was aligned in the redesign. Most other steps in the redesign involve an integration of both processes too. Additionally, the two solutions discussed previously are also integrated into the redesign. Organizing sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks was integrated in several steps because it is found important to be aware of what the opportunities and risks really mean. Moreover, decisions made during the project should be in line with the principles and objectives. A facilitator should support these sessions. Also the platform where opportunities and risks are stored was integrated into the design. This should create consensus and better information exchange in and across (a portfolio of) projects. Specifically, this platform supports identification, definition, assignment and assessment of

opportunities and risks, and should lead to more control and less rework. This answers *research question IV*.

The results of this study show that a facilitator is required to reflect on principles and objectives in order to increase awareness. Also, several studies argue that a responsible person should guide and report the integration of the processes for RM and on a regular basis. Therefore, this study combines these two aspects in the redesign resulting in a facilitator guiding the integration of the two processes, and also reflecting on principles and objectives. Due to this, the connection between risk management and value management was strengthened even more. After all, regularly reflecting on principles and objectives with the guidance of a facilitator increases the awareness of the concept behind RM and VM, allowing them to integrate more effectively. Furthermore, the results argue that a platform could create a connection in and across (a portfolio of) projects. However, this requires guidelines specifying what information is required and how to aggregate and present this information. Within projects these guidelines are clear in general; the problem mainly occurs across (a portfolio of) projects. Thus, this research shows that it is possible to create a connection across (a portfolio of) projects, but attention is required on how to aggregate and present information. All in all, this study shows that VM principles were applied to the ORM process resulting in higher value of the process, because solutions were generated to create more awareness, to create consensus and to provide better information exchange.

References

Abdullah, M. S., Alaloul, W. S., Liew, M. S., & Musarat, M. A. (2021). Delay and Cost Overrun of Palm Oil Refinery Construction Projects: Artificial Neural Network (ANN) Model. *Lecture Notes in Civil Engineering*, 580–589. https://doi.org/10.1007/978-981-33-6311-3_67

Al-Ajmi, H. F., & Makinde, E. (2018). Risk Management in Construction Projects. *Journal of Advanced Management Science*, 113–116. https://doi.org/10.18178/joams.6.2.113-116

Alaqad, M., Gidado, K., & Piroozfar, P. (2015). Integrating value, risk and environmental management at the strategic definition stage. In *Proceedings of 31st Annual ARCOM Conference* (pp. 145-154). ARCOM.

APM. (n.d.). *Risk management*. https://www.apm.org.uk/resources/what-is-project-management/what-is-risk-management/

Aven, T. (2016). Risk assessment and risk management: Review of recent advances on their foundation. *European Journal of Operational Research*, *253*(1), 1–13. https://doi.org/10.1016/j.ejor.2015.12.023

Bluhm, D. J., Harman, W., Lee, T. W., & Mitchell, T. R. (2010). Qualitative Research in Management: A Decade of Progress. *Journal of Management Studies, 48*(8), 1866–1891. https://doi.org/10.1111/j.1467-6486.2010.00972.x

Browning, T. R. (2014). A Quantitative Framework for Managing Project Value, Risk, and Opportunity. *IEEE Transactions on Engineering Management, 61*(4), 583–598. https://doi.org/10.1109/tem.2014.2326986

Browning, T. R. (2019). Planning, Tracking, and Reducing a Complex Project's Value at Risk. *Project Management Journal, 50*(1), 71–85. https://doi.org/10.1177/8756972818810967

Bryman, A. (2012). *Social Research Methods* (4th Revised edition). Oxford University Press.

Burkov, V., Burkova, I., Barkhi, R., & Berlinov, M. (2018). Qualitative Risk Assessments in Project Management in Construction Industry. *MATEC Web of Conferences*, *251*, 06027. https://doi.org/10.1051/matecconf/201825106027

Denney, V. (2020). *Exploring the upside of risk in project management: A phenomenological inquiry.* J. Mod. Proj. Manag.,8, 1–23.

Dallas, M. F. (2006). *Value and Risk Management: A Guide to Best Practice* (1ste editie). Wiley-Blackwell.

De Neufville, R. (2004). *Uncertainty management for engineering systems planning and design.* Engineering Systems Symposium, Cambridge, USA.

Ebrahimnejad, S., Mousavi, S. M., & Mojtahedi, S. M. H. (2008). A model for risk evaluation in construction projects based on fuzzy MADM. *2008 4th IEEE International Conference on Management of Innovation and Technology*, 305–310. https://doi.org/10.1109/icmit.2008.4654381

Farooq, M. U., Thaheem, M. J., & Arshad, H. (2018). Improving the risk quantification under behavioural tendencies: A tale of construction projects. *International Journal of Project Management*, *36*(3), 414–428. https://doi.org/10.1016/j.ijproman.2017.12.004

Floricel, S., Piperca, S., & Banik, M. (2011). *Increasing Project Flexibility: The Response Capacity of Complex Projects*. Project Management Institute.

Hiley, A. and Paliokostas, P.P. (2001) Value management and risk management: an examination of the potential for their integration and acceptance as a combined management tool in the UK construction industry, in *Proceedings of the RICS Foundation Construction and Building Research Conference*, Glasgow, 27–36.

Hubbard, D. W. (2020). *The Failure of Risk Management* (2nd Edition). Wiley.

Hwang, B.-G., Zhao, X., & Ong, S. Y. (2015). Value Management in Singaporean Building Projects: Implementation Status, Critical Success Factors, and Risk Factors. *Journal of Management in Engineering*, *31*(6), 04014094. https://doi.org/10.1061/(asce)me.1943-5479.0000342

ISO. (2009). *ISO GUIDE 73:2009 Risk management — Vocabulary*. https://www.iso.org/standard/44651.html

Key Principles. (2020). IVM. https://ivm.org.uk/value-management/key-principles/

Kishan, P., Bhatt, R., & Bhavsar, J. (2014). A study of risk factors affecting building construction projects. *Int. J. Eng. Res. Technol., 3*, 831–835.

Lin, C. L., & Chen, B. K. (2021). Research for Risk Management of Construction Projects in Taiwan. *Sustainability, 13*(4), 2034. https://doi.org/10.3390/su13042034

Ministerie van Infrastructuur en Waterstaat. (2021). About us. Rijkswaterstaat. https://www.rijkswaterstaat.nl/en/about-us

Moshtaghian, F., Golabchi, M., & Noorzai, E. (2020). A framework to dynamic identification of project risks. *Smart and Sustainable Built Environment, 9*(4), 375–393. https://doi.org/10.1108/sasbe-09-2019-0123

Office of Government Commerce (OGC). (2007). *Achieving excellence in construction, procurement guide 04 risk and value management*, London.

Olsson, R. (2007). In search of opportunity management: Is the risk management process enough? *International Journal of Project Management, 25*(8), 745–752. https://doi.org/10.1016/j.ijproman.2007.03.005

Othman, A. A. (2005). "Value and risk management protocol for dynamic brief development in construction." *Emirates J. Eng. Res.*, *10*(2), 23–26.

Ranesh, A., Zillante, G., & Chileshe, N. (2013). Towards the Integration of Risk and Value Management. *Australasian Journal of Construction Economics and Building - Conference Series, 1*(2), 43. https://doi.org/10.5130/ajceb-cs.v1i2.3165

Shen, Q., & Liu, G. (2003). Critical Success Factors for Value Management Studies in Construction.

Journal of Construction Engineering and Management, *129*(5), 485–491. https://doi.org/10.1061/(asce)0733-9364(2003)129:5(485)

Sanni-Anibire, M. O., Mahmoud, A. S., Hassanain, M. A., & Salami, B. A. (2020). A risk assessment approach for enhancing construction safety performance. *Safety Science*, *121*, 15–29. https://doi.org/10.1016/j.ssci.2019.08.044

SAVE International. (n.d.). *About Value Engineering*. https://www.value-eng.org/page/AboutVM

Vorgers, D. (2020). Challenges in Risk Management Strategies in Public Infrastructure Projects.

Ward, S., & Chapman, C. (2011). *How to Manage Project Opportunity and Risk*. Wiley.

Willumsen, P., Oehmen, J., Stingl, V., & Geraldi, J. (2019). Value creation through project risk management. *International Journal of Project Management*, *37*(5), 731–749. https://doi.org/10.1016/j.ijproman.2019.01.007

Yirenkyi-Fianko, A. B., & Chileshe, N. (2015). An analysis of risk management in practice: the case of Ghana's construction industry. *Journal of Engineering, Design and Technology, 13*(2), 240–259. https://doi.org/10.1108/jedt-04-2012-0021

Appendix A, Interview guide

This is the interview guide in Dutch that was used for all interviews. This interview guide is based on principles from the book Social Research Methods by Bryman (2012).

Introductie	• *Dank vooraf* • *Introductie van mezelf:* naam, studie, start onderzoek. • *Structuur interview:* algemene informatie, vragen, afsluiting. • *Doel interview:* inzicht krijgen in het huidige proces van kansen- en risicomanagement en bepalen waar waarde is ingebed en waar deze kan worden vergroot. • *Duur interview:* ongeveer een half uur, overleg uitloopmogelijkheid. • *Privacy:* opnemen interview. • *Eventuele vragen vooraf*
Introducerende vragen	• Zou je iets kunnen vertellen over jouw functie en rol bij Rijkswaterstaat? • Hoe verhoudt deze functie zich tot kansen- en risicomanagement?
Vragen over waarde van het kansen- en risicomanagement proces	• Welke stappen in het kansen- en risicomanagement proces zijn volgens jou waardevol? Zou je deze stappen kort kunnen beschrijven en kunnen toelichten waarom deze stappen waardevol zijn? • Hoe zou de waarde van deze stappen behouden kunnen worden? • Welke stappen in het kansen- en risicomanagement proces zijn volgens jou minder waardevol? Zou je deze stappen kort kunnen beschrijven en kunnen toelichten waarom deze stappen minder waardevol zijn? • Hoe zou de waarde van deze stappen vergroot kunnen worden? • Kunnen de waardes van de zojuist besproken stappen worden beschouwd als onafhankelijk, of hebben deze ook invloed op elkaar? • Als deze waarde vergrotende elementen geïmplementeerd zullen worden, hoe zal dit dan doorwerken op project overstijgend niveau?
Vragen over ervaringen met andere organisaties	• Heeft Rijkswaterstaat ervaringen met kansen- en risicomanagement proces van andere organisaties en zo ja, wat valt hierin op in relatie tot hoe Rijkswaterstaat hier mee omgaat?
Afsluitende vragen	• Terugkijkend op dit interview, wat is het belangrijkste punt dat je zou willen meegeven? • Heb je nog tips of ideeën die je zou willen meegeven?
Afsluitend	• *Transcriptie* • *Ervaring interview* • *Dank achteraf*

Appendix B, Results analysis session

Five experts in the field of opportunity and risk management of Rijkswaterstaat contributed to this session. Three proposals to increase value, and the relationship between these proposals were discussed. The highlights of this session are presented in the following tables.

Proposal 1: Organize sessions to reflect on principles and objectives, and to spend time on the concept behind seizing opportunities and managing risks.	
Theme	**Quotations from analysis session**
Current situation	"Those types of sessions happen quite rarely in my opinion, but when they do they can be energetic."
	"And how often is that done? Yes, in my opinion often once at the beginning of a project, and when a project has time left."
	"We are now trying to roll this out to all clusters, and we are already doing this in a number of clusters, and these are enthusiastic clusters that also really see the benefit of risk management at a strategic level. We do not do this completely planned, but almost every two months we do this with a team to pick up some information."
	"The starting points and objectives are usually coming from quality management because they have more time for such sessions with the teams. And you see that in both the risk management and quality management disciplines, getting those objectives clear is still a task for both disciplines."
	"And for that bit, the concept behind seizing opportunities and managing risks, we discussed this in most of the project clusters, when drawing up a kind of (...) working process description of how we as a cluster actually approach a project."
	"So a little bit of role maturity is very important I think, and I think that is where it lacks sometimes in Rijkswaterstaat projects."
Implementation	"In my opinion, you need a facilitator, so a quality management advisor and a risk management advisor for example, coming together with a project management team. Then you are talking about the Integral Project Management role holders (...) and starts talking about the goals projects have."
	"So the maturity of these role holders in terms of seizing opportunities and managing risks is also very important for how an implantation can be in which you start reflecting on objectives."
	"With regard to implementation, I see the problem that the teams are often actively involved in the current affairs of the day, and spend little time and energy in reflection."
Advantages	"The more often you reflect on objectives, the more actively you are involved with the risks that threaten the goals but also with the opportunities you can see to make your goals easier or better or perhaps even, more comprehensive."
Disadvantages	"If you just work on starting points and objectives, then you are also risking that when focusing very strongly on that, on digesting principles and objectives, then they will keep changing and you are busy with nuances and such all the time."

Proposal 2: Discuss strategies and analyses of opportunity and risk management on organizational level and project level to create a connection, and intensify coordination between the opportunity and risk management advisor and the advisor for portfolio management.	
Theme	**Quotations from analysis session**
Current situation	"We have some ICT systems that could be used to extract some information, but then you should indicate from a project-wide level, so perhaps from an organizational or portfolio perspective, what information you are looking for and how projects can deliver this. This is not happening currently."
	"There are clusters, depending on their own project approach, having some kind of basic risk file (...), but I see that most project management managers are quite often within clusters and do not really transcend clusters."
	"The advice is to treat similar problems together, but this is not taken into account yet."
Implementation	"What I do see as added value, or could see as added value, if you are still talking about the project level, is that you look at the trend in risks. This is about risks with certain themes and you might be able to do something with this. It would help to communicate these in a smart way because each project actually has its own risk file and there is a lot of knowledge stored in all those different files. Only if you look at the project as a whole you see that very little is done with it. There is a lot more that could be done with this, especially when it comes to comparing risks and sharing risks between projects. The same argument for opportunities. It is about really carrying them upwards, because if there are five or maybe ten projects with the same risk, you can also think about how we can do something with this as the organization instead all projects finding it out independently."
	"One obstacle for implementation is that there are differences in interest between portfolio management and projects or clusters. Even between clusters and projects there are already differences in interest. That is a threshold that you could do something with."
	"As far as I am concerned, it is really about what information you can and want to share with each other. If you can coordinate this with each other, you are already well on your way. I think projects can deliver a lot, but it is useless to deliver a lot when you know nothing is done with it. So, if you can indicate as a portfolio what you need to take away certain risks, then projects will quickly supply information."
Advantages	"Added value can be created in two directions if there is good coordination between portfolio and projects, only it should be made visible. For projects, it can help if they know that the organization also helps with the problems of projects. On the other hand, it may help the organization to know that on certain themes there are several projects with certain problems."
Disadvantages	"I do not see more intensive coordination between the opportunity and risk management consultant and the portfolio management consultant as a possibility within the organization."

Proposal 3: Aggregate and simplify information to create a connection in and across (a portfolio of) projects.	
Theme	**Quotations from analysis session**
Current situation	"If you look at the various files from a project-wide level, for example as our opportunities and risk management pool, or as a portfolio manager, it is difficult to extract connections between projects because there is not much uniformity based on themes. So, at the moment this does not happen very often in order to get information bottom-up."
	"We are working on this with the pool (...), which is something where you try to organize risk management more on an organizational level. However, then the focus is less on projects, so that is a very difficult puzzle."
	"We do try to facilitate easier communication between projects in the future by writing down their approach in a uniform way, but there are so many interests involved in the organization."
Implementation	"What you actually want is to create a need among those parties, so that they start asking for it. If we can then connect the systems to that, so that you supply all information and gladly explains it, then you create an information flow that is hopefully valuable."
	"So yes, if you ask what needs to be done for implementation, then you have to make it very clear what information you need, what information you need to share, and what information needs to be aggregated in what direction, because as long as that is not clear, nobody is going to do it actively."
Advantages	"The exercise from last year with focus on risk management was interesting. You were able to extract all that from IPS, and only by asking everyone the question. I thought that was actually suitable for a follow-up."
Disadvantages	"So it is quite tricky how you are going to aggregate risk information upwards, and the same goes for the targets."

Relationship between the proposals	
Description	**Quotations from analysis session**
Proposal 2 vs. proposal 3	"I see a bit of the same idea here too, but this one is more about information exchange and the previous one was a bit more general. However, the same comments apply to both."
	"Idea 2 and idea 3 are very close to each other. Namely, from your strategies and analyses a certain need for information is created and that need for information can then be met by an information flow, so they are very close to each other as far as I am concerned."
Proposal 1 vs. proposal 2 and proposal 3	"The first idea, as far as I'm concerned, is really within a project. At least that's how I have seen it so it is quite separate from it."
Proposal 1 vs. proposal 2	"Those principles and objectives should come partly from the second idea, because on the one hand, you have the objectives of your project, and on the other hand, you have a vision of how we want to be or become as an organization and what we want to develop. So I do see a relationship there."