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DURA VERMEER

Early Warning Signs in Risk Management

Improve Accuracy of Cost Contingency by implementing Early Warning Signs in Risk Management to Prevent Cost Overruns

Master Thesis by
Suzan van Werkhoven
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Master thesis

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Improve Accuracy of Cost Contingency by Implementing Early Warning Signs in Risk Management to prevent Cost Overruns

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Author	Suzan van Werkhoven
Student number	4432282
Date	05-01-2022

Graduation Committee:

Prof. dr. H. L. M. Bakker	TU Delft, Faculty of Civil Engineering and Geosciences	Chairman
Dr. M. Leijten	TU Delft, Faculty of Technology, Policy and Management	First supervisor
E. Hoseini, PhD	TU Delft/ Mazars	Second supervisor
Ir. V. J. W. Laging	Dura Vermeer	Company supervisor

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I. Preface

This master thesis is the last report I am writing as a student at the Delft University of Technology to conclude the study Construction Management & Engineering. Despite the challenges and limitations due to the corona pandemic, resulting in working from home and online meetings, I enjoyed the process of conducting this research from the beginning till the end. Risk management has always fascinated me and I am pleased to contribute to the academic knowledge and practical applications of risk management.

I would like to acknowledge everyone who supported me and contributed to my research. First of all, I would like to thank my parents for supporting my study and my decisions. I am thankful to my graduation committee for guiding me in this research process. Thank you, Hans Bakker, for the constructive and direct feedback, which helped me to improve the quality of my research; Martijn Leijten for his enthusiasm and inspirational meetings at the start to shape the research outline, but especially in the final month before the green light meeting with valuable feedback and challenging remarks that often left me with more questions after our meeting than before; Erfan Hoseini for his devotion to the subject and to provide me with personal feedback during online meetings; and Vincent Laging for his passion for risk management and academic approach, enabling all means necessary to execute my research at Dura Vermeer and encouraging to meet the company and the team. Furthermore, I would like to express my gratitude to the interviewees, Silvester Pastoor and Ruben van der Zanden for taking the time to devotedly elaborate on their projects, with transparency about issues and processes. And finally, I would like to thank Daniel for the lovely view in our home office and endless support.

Suzan van Werkhoven

Delft, January 5th 2022

II. Summary

Despite the severity and high frequency of cost overruns in construction projects, it is considered a rule rather than an exception. This phenomenon occurs when the initially estimated budget does not suffice the actual costs needed to realise the project. Uncertainty and bias challenge the ability to make cost estimates. Incorrect estimates of indirect costs, including risks, reservations and project organisational costs, are acknowledged as a frequent cause for cost overruns.

Risk management is an important competence to manage and control project uncertainties. A risk analysis is translated to the project budget via cost contingency. This is reserved for materializing risks, mitigation measures and unforeseen circumstances within the scope of the project, in order to avoid cost overruns. The most commonly used method is range estimating, which is a probabilistic method using Monte Carlo simulation to estimate the required contingency. Literature offers multiple methods for cost contingency management during project execution, but these are not often applied in practice. In practice, accuracy of a cost contingency estimate is reflected by the selection of a confidence interval from the simulated Monte Carlo distribution. This determines the amount of cost contingency that will be included in the budget. Literature offers various reasons for inaccuracy within cost contingency estimates, namely poor practice and uncertainty, project characteristics and dynamics, and strategic misinterpretations. Regardless of the risk and cost contingency management tools in literature and their application in practice, project uncertainties are still underestimated and insufficiently managed.

During the execution phase projects are monitored with performance indicators, which provide information about past events or activities. This means these indicators are lagging, hence it limits proactive project management. On the contrary, leading indicators could function as early warning signs as they present themselves before potential issues arise, or risks materialize.

The objective of this research is to improve the cost contingency process by implementing early warning signs, in order to proactively manage projects and minimise cost overruns and materialized risks. In order to achieve this objective the following main research question is formulated.

How can early warning signs be used in large construction projects to improve accuracy of cost contingency estimates and management in order to minimize cost overruns?

This question is answered by performing an analysis of the project budget, cost contingency processes and early warning signs, both in literature and practice. For the theoretical part, a literature study is conducted, which summarises the available cost contingency processes for both estimating and managing cost contingency. Consecutively, an empirical study consisting of case studies and an expert session with risk managers is conducted. A set of risks from two projects are analysed to map their causes and relations to other risks. These causes are categorised into themes, which form the basis for an in-depth analysis, in which the chronological order of risks and the development of risk status and RISMAN scores over time are evaluated.

Concluding from the empirical study, early warning signs can be implemented in the cost contingency process by shifting the focus of risk management from mitigating and managing the effects of risks towards the causes of risks. Cause-and-effect or bowtie analysis is useful to explore the causes of risks. Subsequently, risk strategies and mitigation measures can be more effective when aimed at the origin of the issue, instead of the direct issue leading to the risk. It is valuable to examine the risks as a system or

network, instead of single problems, because it provides a better representation of reality and the links between risks or other events reveal information about correlation or side effects. Consequently, mitigation measures can increase in efficiency, when one cause, leading to multiple risks, is targeted. Furthermore, materialization of a risk is detected as an early warning sign which contains information about causes or circumstances that trigger other risks as well. Additionally, the increase of a RISMAN score indicates a change in project circumstances and therefore can be used as an early warning for materialization of risks. The justification for an increase in RISMAN score is diverse, and should thus be analysed to reveal the specific information needed to prevent materialization of risks.

In order to support this focus on causes of risks, tools should be available to document, track and manage causes. It is recommended to use a risk management tool that facilitates connecting risks to multiple causes and vice versa. Additionally, the chain of events should be implemented by linking causes to other causes. And to be able to manage mitigation and its effectiveness it is recommended to connect mitigation measures to causes and add status labels to causes, like risks currently have.

Before implementing early warning signs in the cost contingency process, improvements are suggested to enhance the current cost contingency management process. It is recommended to divide bulk contingency among risk causes, work packages or other suitable levels to create more insight and control over the cost contingency. A distinction between identified and unidentified risks is suggested, because the first determines the cost contingency and the latter is currently not included in the estimation, but needs to be managed with the same budget. Additionally, the cost contingency requires tracking during the project execution in order to provide insight into the development during project phases and the actual spending pattern. This data can be stored in a common database, which can be referenced by other projects. Including this so-called ‘outside view’ improves accuracy of the cost contingency estimates.

The common database contributes to the early warning sign approach as well, because it overcomes the in the case study identified ‘surveillance filter’, by improving collection and transfer of information. The identification of early warning signs is possible with risk analysis and cause-and-effect analysis. However, most early warning signs have a 'soft' character, and are difficult to capture with standard risk management methods. Rather, they present themselves in the coffee corner chat, lunchroom, or informal conversations. Therefore, awareness of this concept is of high importance in making an early warning sign approach to risk management effective.

III. Samenvatting

Ondanks de aard en mate van kostenoverschrijdingen in grote infrastructuurprojecten, wordt het fenomeen als gebruikelijk en normaal beschouwd. Wanneer de daadwerkelijke kosten die nodig zijn om het project te realiseren groter zijn dan de initieel ingeschatte kosten spreekt men van een kostenoverschrijding. Het is een uitdaging om inschattingen te maken van de benodigde kosten, omdat het project blootgesteld wordt aan onzekerheden en subjectiviteit. Een onjuiste inschatting van indirecte kostenposten is een veelvoorkomende oorzaak van kostenoverschrijdingen.

Risicomanagement is een belangrijke vaardigheid om onzekerheden rondom een project te beheersen. Een risicoanalyse vertaalt zich naar een onderdeel van het projectbudget via de risicoreservering. Dit is gereserveerd voor kosten gerelateerd aan opgetreden risico's, beheersmaatregelen en onvoorziene omstandigheden binnen de scope van het project, zodat kostoverschrijdingen voorkomen worden. Een Monte Carlo simulatie met 'Bandbreedte inschattingen' is de meest gebruikte, probabilistische methode om de risicoreservering te bepalen. De literatuur biedt verschillende methodes voor het managen van de risicoreservering tijdens de uitvoering van een project, maar deze worden in de praktijk niet toegepast. Accuraatheid van een inschatting wordt behaald door het selecteren van een 'betrouwbaarheids interval' op de uit de Monte Carlo geproduceerde distributie. Hieruit wordt de risicoreservering bepaald. De redenen voor het niet behalen van een accurate kosteninschatting zijn gebrekkige uitvoering en onzekerheid, projecteigenschappen en -dynamiek, en strategische misinterpretaties. Ondanks de beschikbare risicomanagement methodes en middelen in de literatuur, maar ook toegepast in de praktijk, worden projectonzekerheden nog steeds onderschat en onvoldoende gemanaged.

Tijdens de uitvoeringsfase worden projecten gemonitord door middel van prestatie indicatoren. Deze geven informatie over eerdere incidenten of activiteiten, wat betekent dat de indicatoren achterlopen op de stand van zaken en proactief management limiteert. Daarentegen zouden leidende indicatoren als 'early warning signs' kunnen functioneren, omdat zij zich vertonen voordat een mogelijk probleem zich voordoet of risico optreedt.

Het doel van dit onderzoek is om het risicoreserveringsproces te verbeteren door 'early warning signs' te implementeren, om zo proactief projecten te managen en kostenoverschrijdingen en opgetreden risico's te beperken. Het onderzoek beantwoord de volgende vraag om het doel te behalen.

Hoe kunnen 'early warning signs' worden ingezet voor grote infrastructuurprojecten om de accuraatheid van risicoreserveringen en het management ervan te verbeteren om kostenoverschrijdingen te beperken?

Deze vraag wordt beantwoord door het projectbudget, risicoreserveringsprocessen en 'early warning signs' zowel in de literatuur als praktijk te analyseren. Voor het theoretische gedeelte is een literatuurstudie uitgevoerd, welke de beschikbare processen voor zowel inschattingen als management van risicoreserveringen samenvat. Daaruit volgt een empirische studie waarin projecten zijn geanalyseerd en een expert sessie met risico managers is gehouden. Een selectie risico's uit de projecten is nader bestudeerd om de oorzaken en relaties met andere risico's in kaart te brengen. Deze oorzaken zijn vervolgens gecategoriseerd in thema's, welke een basis vormen voor een verder analyse naar de chronologische volgorde van risico's en de ontwikkeling van risico status en RISMAN scores over tijd.

Uit de empirische studie is afgeleid dat 'early warning signs' geïmplementeerd kunnen worden in het risicoreserveringsproces door de focus van het risicomanagement te verschuiven van het mitigeren en managen van effecten naar oorzaken. Een oorzaak-en-effect analyse is nuttig om de oorzaken van risico's te vinden. Daarnaast kunnen risicostrategieën en mitigerende maatregelen meer effect hebben wanneer de oorsprong van het probleem of risico aangepakt wordt, in plaats van de directe oorzaak. Het is waardevol om risico's als een systeem of netwerk te beschouwen, in plaats van individuele vraagstukken, omdat dit enerzijds een betere representatie geeft van de realiteit en anderzijds cruciale verbanden tussen risico's of andere gebeurtenissen zichtbaar maakt. Hierdoor kunnen mitigerende maatregelen ook efficiënter worden ingezet, omdat het mitigeren van één oorzaak kan leiden tot het verlagen van meerdere risico's. Daarnaast is er uit het onderzoek gebleken dat het optreden van een risico als 'early warning sign' kan functioneren, omdat het informatie bevat over de oorzaak of veranderende context van het risico. Hetzelfde geldt voor een toename van RISMAN score. Dit duidt mogelijk op een verandering in het project, maar het is aan te raden om de reden van toename te analyseren en de bredere context van het toenemende risico netwerk in acht te nemen.

Om deze focus op oorzaken in het management proces te faciliteren, moeten er middelen beschikbaar zijn om oorzaken te documenteren, bijhouden en managen. Het is aan te raden om een medium te gebruiken dat in staat is om risico's aan meerdere oorzaken te koppelen, en andersom. Daarnaast is het van belang om de volgordelijkheid te kunnen verwerken door oorzaken aan andere oorzaken te koppelen. Om vervolgens de mitigatie te kunnen managen en de effectiviteit te meten is het aan te raden om de mitigerende maatregelen met oorzaken te koppelen en een status label te hangen aan de oorzaken, zoals dat nu al van toepassing is op risico's.

Voordat 'early warning signs' geïmplementeerd kunnen worden in het risicoreserveringsproces, zijn enkele aanbevelingen gedaan om het huidige proces te verbeteren. Het is aan te raden om de huidige pot risicoreservering te verdelen over verschillende, kleinere posten, zoals oorzaken van risico's, werkpakketten of andere passende subonderdelen om zo meer inzicht en kennis te genereren in de risicoreservering. Een verdeling tussen geïdentificeerde en (nog) niet geïdentificeerde risico's wordt geadviseerd, omdat de huidige methode hier geen rekening mee houdt en de grootte van de risicoreservering bepaald door de geïdentificeerde risico's, maar in de uitvoeringsfase wel beide soorten risico's ervan moet betalen. Daarnaast is het van belang om de risicoreservering gedurende het project bij te houden en te documenteren, omdat dit inzicht biedt in de ontwikkeling tijdens de verschillende projectfasen en het daadwerkelijke uitgavenpatroon. De geproduceerde data kan worden opgeslagen in een database, welke geraadpleegd kan worden door andere projecten. Deze objectieve en externe bron draagt bij aan de verbetering van de accuraatheid van volgende inschattingen van de risicoreservering.

De gemeenschappelijke database bevordert ook de 'early warning sign' implementatie, omdat het de 'surveillance filter' deactiveert door de verzameling van data en overdracht van informatie verbetert. De identificatie van 'early warning signs' is in ieder geval mogelijk door middel van risicoanalyse en oorzaak-en-gevolg analyse, zoals toegepast in dit onderzoek. Daarentegen hebben de meeste 'early warning signs' een zachter karakter en zijn ze minder makkelijk te herkennen met deze methodes. Maar tijdens gesprekken in de koffiehoek, kantine of andere informele conversaties komen ze vaak boven tafel. Daarom is het van groot belang dat deze inzichten aan het licht worden gebracht om de 'early warning signs' aanpak in risicomanagement effectief en succesvol te maken.

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INTRODUCTION

1 Introduction

1.1 Context

In the following paragraphs the context of this research is discussed, while illustrating the issue of interest in current cost and risk management in practice and literature.

1.1.1 Cost Overruns

Large cost overruns in construction projects are a global phenomenon (Morris en Hough 1987). Many studies have been conducted addressing the cost overruns (Flyvbjerg, Holm and Buhl 2002), (Flyvbjerg, Bruzelius and Rothengatter 2003), (Flyvbjerg, Holm and Buhl 2003), (Cantarelli, Molin, et al. 2012). They found that the cost overrun per project can vary from 5-86% according to the study by Cantarelli, et al. (2012). While the recurrence of cost overruns differs per study, it was found to be more than 25% by Flyvbjerg et al. (2002) and 90% by Flyvbjerg (2003). Despite the severity and frequency of this phenomenon, it is considered a rule rather than an exception in the construction projects (Fister Gale 2011), (Ika 2009), and especially large and complex projects are subjected to cost overruns (Flyvbjerg, Holm and Buhl 2002).

The concept of cost overrun can be described as a situation in which the initial estimated budget does not suffice to realise the project according to the requirements. In other words, the budget is lower than the actual costs. The parts of the budget that are frequently underestimated, are indirect costs (Veen 2018). This part of the budget is composed of costs for the project organisation, risks and reservations.

1.1.2 Cost Estimates & Uncertainty

The cost estimates that form the budget are hard to determine, because some details and parts of the scope of the project are unknown, and the future is uncertain. Moreover, the estimates are based on expert judgement, biases and interpretations, either personal perspective or subjectivity, which makes it difficult to form a fully objective estimate. Besides, the estimate itself can be inaccurate due to, for example, inexperience or project complexity. In literature incorrect cost estimating is mentioned as one of the most frequently identified causes of project overrun (Olawale and Sun 2015), (Hoseini 2020).

> **“Uncertainty, introduced by different factors, can jeopardize the objectives of projects.”**
>
> **Hoseini, 2020 (p. 150)**

Construction projects are subjected to uncertainty in different ways, due to, for example, a long period of development, a vast amount of resources and collaborations and political issues (Mustafa and Al-Bahar 1991) (Chapman and Ward 2003) (Yeo and Ren 2009) (Hillson 2012) (Hopkinson 2012) (Schwindt and Zimmermann 2015). Therefore, it is likely that the initial estimate does not suffice to realise the project (Nicholas and Steyn 2017). It can be concluded that the context of construction projects, unlike a controlled laboratory environment, is subjected to fluctuations and changing circumstances: uncertainty. Especially in the beginning of a project, limited information is available. However, cost estimates have to be made in this early project phase and are therefore subjected to uncertainty.

At any given point in time, uncertainty increases when predictions are made further away in the future. This is illustrated in Figure 1.1. Uncertainty of a project can be referred to as a bandwidth or range of possible outcomes, rather than a fixed number or outcome. Especially in the beginning of a project many aspects are still unknown, which makes it difficult to make predictions about the project in the future.

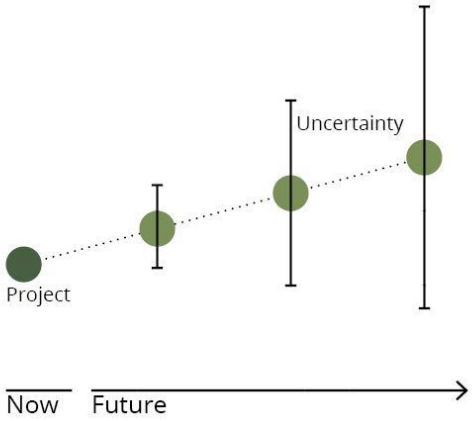


FIGURE 1.1 PROJECT UNCERTAINTY (E.G. IN COST ESTIMATES) AT A CERTAIN POINT IN TIME

1.1.3 Risk Management & Cost Contingency

Risk management is used to control these uncertainties in a project and is therefore considered to be the most important skill required for projects with high uncertainty (Krahn en Hartment 2006). Despite risk management tools available in practice and in literature, project costs are still underestimated and uncertainties are not managed well (Flyvbjerg, Holm and Buhl 2002), (Flyvbjerg, Holm and Buhl 2003), (Flyvbjerg, Garbuio, & Lovallo, 2009).

Cost contingency is introduced to deal with uncertainties and avoid cost overruns (Yeo 1990) (Mak and Picken 2000) (Lhee, Issa and Flood 2012) (Marco, Rafele and Thaheem 2016) (Hoseini 2020). This cost contingency is based on a risk analysis, followed by an estimation of money needed to cover upcoming risks and uncertainties. This is illustrated in Figure 1.2. The left side shows the early project phases, like the tender phase, in which a risk analysis is executed, resulting in a set of project risks (moving to the right). These risks are expressed in terms of money (moving up) and are called a risk reservation or cost contingency, which is included in the budget (moving up). During the project execution (third column), all aforementioned aspects are managed. A simplification of the results are visualised in the last column of Figure 1.2. A favourable outcome of the budget is when the costs are managed, contrary to cost overruns. Likewise, the project team generally prefers their risks to be managed over materialized ones.

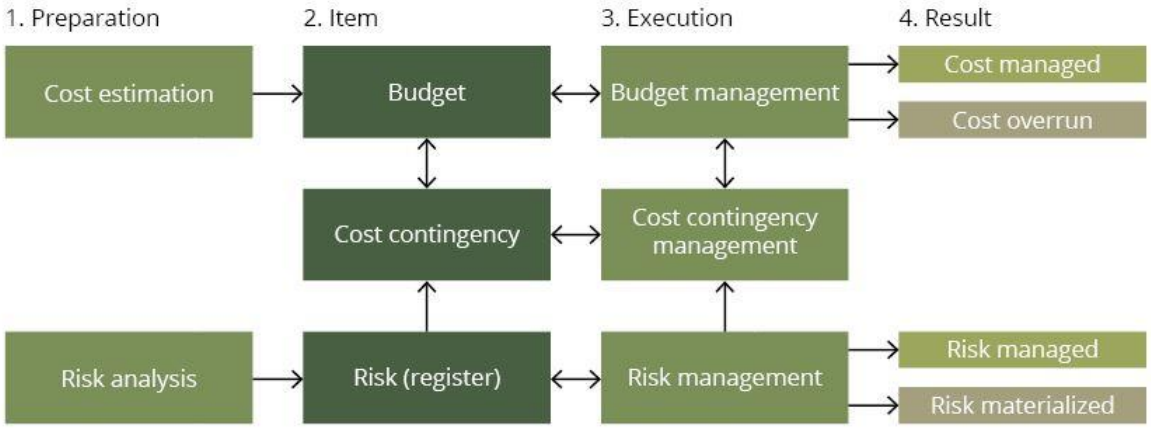


FIGURE 1.2 RELATION BETWEEN BUDGET AND RISK

Despite the apparent uncertainty in cost estimates, as explained before, it is still not adequately recognized and efficiently incorporated by many construction projects (Reilly, et al. 2004) (Treasury 2010) (Hollman 2012). Cost contingency needs more consideration in practice.

> ***"While most of the current literature deliberates on the accuracy of cost estimate, in general, studies in [sic] the accuracy of cost contingency are scarce."***
>
> ***Hoseini, 2020 (p. 188)***

Currently, risks are assessed individually. Their probability of occurrence and consequences are estimated and registered, followed by assessment and selection of unacceptable (high) risks. Then these risks are managed with mitigation measures, to lower the risk (probability and/ or consequence). Often, causes and effects of the analysed risks are documented. However, there is no risk management method available or applied to assess and analyse the relation to other risks, such as common causes, chain of events, correlation and more. On the other hand, a concept known as early warning signs or lead indicators is known in literature, but has not been implemented in risk management processes. The concept of early warning signs suggest that there are signs in the project that reveal itself before the harmful event actually materializes. Early warning signs in risk management could conceivably provide information about causes of risks and relations between risks. If the causal chain of events is known, the risk managers can act upon it and potentially prevent high risks from materializing, resulting in fewer cost overruns and being more in control of the project.

1.2 Research

In the following paragraphs the research objectives, question, method and scope will be discussed, providing the structure and goal of this research.

1.2.1 Research problem

The problem is the occurrence of large and frequent cost overruns in construction projects, caused by inaccurate estimation of costs. This is a result of uncertainty in these projects, due to the long duration, altering circumstances and multifarious resources and stakeholders. When a risk is analysed to address the uncertainty of a project, it is expressed in the budget by means of a cost contingency. Even though there are methods available for both risk analysis and cost contingency estimation, many projects still fail to address uncertainty. Cost contingency is insufficiently recognized and incorporated in practice and literature is scarce. Additionally, risks are analysed individually, missing the common causes and chain of events leading to materialization of risks.

1.2.2 Research objective

The objective of this research is to limit the cost overruns in large infrastructure projects, by focussing on the cost contingency estimates and risk analysis. By demonstrating a chain of events and risks, the presence of early warning signs in projects is confirmed. Future projects can apply and implement this concept to act early on in the project, to minimize costs and materialized risks.

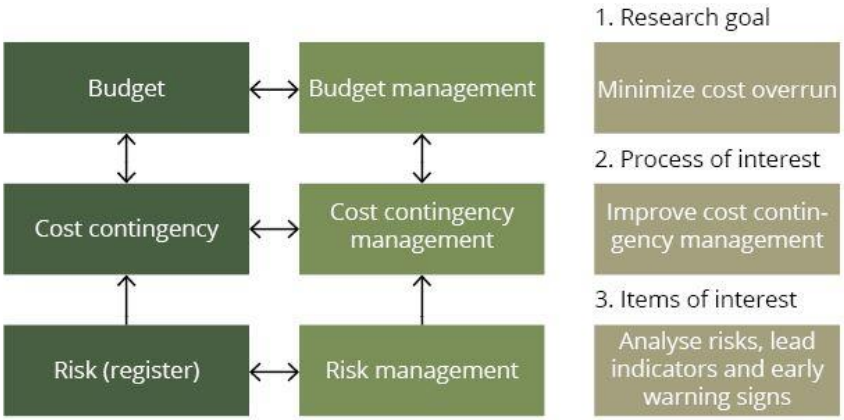


FIGURE 1.3 VISUAL REPRESENTATION OF RESEARCH OBJECTIVE

1.2.3 Research question

This research will answer the following research question to obtain the abovementioned objective.

How can early warning signs be used in large construction projects to improve accuracy of cost contingency estimates and management in order to minimize cost overruns?

To answer this research question the following subquestions are formulated:

1. How is cost contingency determined, monitored and controlled and why is it often inaccurate?
2. What is an accurate estimate?
3. What are early warning signs and how are they identified?
4. Which early warning signs can be found in finished projects?
5. How can the current cost contingency process be adjusted to include early warning signs?

1.2.4 Thesis Outline

This thesis is divided into three sections. The literature study entails two chapters, of which chapter 2 'Cost Contingency' answers question 1 and 2 and chapter 3 'Early Warning Signs' answers question 3. The next section contains the empirical study. Chapter 4 'Processes at Dura Vermeer (Landelijke Projecten)' discusses the processes of the company of interest and compares is to the processes identified in literature in the previous section. Then chapter 5 'Case Studies' and 6 'Discussion' aim to answer question 4, while chapter 5 elaborates on the data from the projects and methods used, chapter 6 focusses on the interpretation of the data and its relevance to the research question. Chapter 7 'Expert Session' reflects on question 5 and the other findings in the case study. Finally, all results from the research are summarized in chapter 8 'Conclusion & Recommendations', which answers all subquestions and finally the main research question.

1.2.5 Research method

Questions 1 to 3 will be answered by means of a literature study. The conclusions of these questions will be used as input for the final subquestion. Additionally, the findings are compared to processes of Dura Vermeer by interviewing experienced risk managers and project controllers. Question 4 will be answered by executing a case study. Archived data from the project, such as progress reports and the risk register, are analysed by a desk study and discussed with the project specific risk managers to check for correct interpretation. Furthermore, the risk manager is interviewed to retrieve more in-depth information about the risk and context of the project. More detailed methods and requirements of the case studies will be discussed in the relevant chapter. Question 5 will be partially concluding from the previous subquestions and following from the case study. Additionally, an expert session is organized with some risk management experts from Dura Vermeer to reflect on the findings from the case studies and discuss the current process, developments and improvements.

1.2.6 Scope

The projects are analysed from tender phase until project completion. Finished projects are used for this analysis, so project performance and results can be analysed in the research.

Scope changes are diversions from the initial contract or assignment initiated by the client. Since scope changes result in (partial) changes in the project definition and assignment, it will not be elaborated upon in this research. This means that risks will be analysed, but requests for deviations (in Dutch 'VTW', which means 'verzoek tot wijziging') or deviations in the budget due to scope changes will be neglected.

LITERATURE STUDY

2 Cost Contingency

The following chapter clarifies the concept of cost contingency by elaborating on its purpose within the budget, the estimation methods and management processes. Additionally, the importance of accuracy of a cost estimate is discussed, and why cost contingency estimates often are inaccurate.

2.1 The Budget

The budget of a construction project is composed of multiple elements, which can be seen in Figure 2.1. For the base estimate, a distinction is made between direct and indirect costs (Burke 2003). Direct costs consist of labour costs, material costs and capital equipment, which is needed, for example, for temporary constructions and tools on the building site. Indirect costs are costs that cannot directly be linked to a specific work package or task, but they are spread across all activities (AACE 2014). Administrative costs, transportation, training and overhead costs, like project management and legal support are examples of indirect costs. The last element of the base estimate are allowances. These costs are added to the direct and indirect costs to cover the lack of scope detail or 'known unknowns', for example, material inefficiencies, rework, non-productive construction time or weather conditions (Bakker and Kleijn 2014).

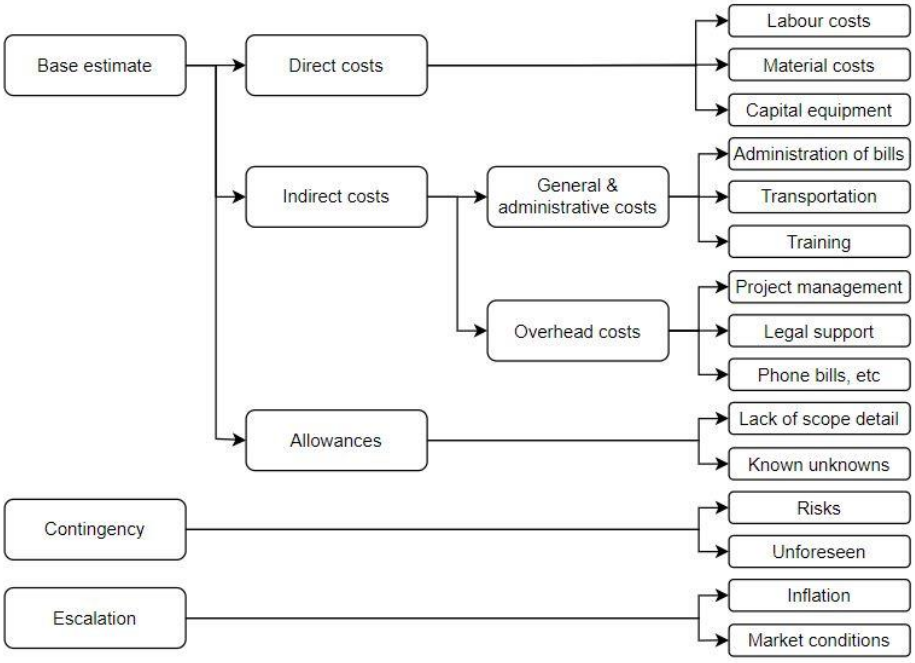


FIGURE 2.1 BUDGET COMPONENTS (ADJUSTED ILLUSTRATION FROM BAKEER AND KLEIJN (2014))

2.1.1 Escalation

This part of the budget is meant to cover for costs due to uncertain changes in technical, economic and market conditions (AACE 2014). This includes inflation, sudden increase of material prices or changes in the personnel costs due to national regulations (in Dutch: CAO).

2.1.2 Cost Contingency

On top of the base estimate contingency is added. It covers uncertainty in quantities and activities, inadequacies in the base estimate (Bakker and Kleijn 2014) and unforeseeable elements of cost within the defined project scope (AACE 2013). With this cost contingency included in the budget, the risk of budget overrun can be reduced to an acceptable level (Yeo 1990) (Mak and Picken 2000) (Chapman and Ward 2003) (Sonmez, Ergin and Birgonul 2007) (Kwak and Ingall 2009) (Lhee, Issa and Flood, Prediction of financial contingency for asphalt resurfacing projects using artificial neural networks 2012) (Bakker and Kleijn 2014) (Senesi, Javernick-Will and Molenaar 2015) (Marco, Rafele and Thaheem 2016) (Nicholas and Steyn 2017) (PMI 2017) (Veen 2018) (Hoseini 2020). However, contingency will not suffice for all uncertainties. Therefore, it should be calculated properly in the preparation phase and managed wisely during the execution phase (Baccarini 2004) (Barraza and Bueno 2007).

Known unknowns & unknown unknowns

The known-unknown matrix reflects types of certainty and uncertainty. The y-axis in Figure 2.2 demonstrates awareness of a certain event and the x-axis reflects the level of knowledge about it.

KNOWN KNOWN The top right corner represents the facts: the things we know we know. This quadrant shows certainty ('fixed' prices in the budget).

UNKNOWN UNKNOWN The bottom left corner are events that we don't know we don't know, for example, pandemics or 'black swans'. These are unforeseeable situations within the scope of the project.

KNOWN UNKNOWNS Then Known Unknowns are things that are uncertain but we are aware of their potential effect on the project (reflected by risks in the budget). Risk management addresses this quadrant.

UNKNOWN KNOWNS The Unknown Knowns are factors such as intuition, culture, reflex, etc. These factors should have been Known Knowns, but were not identified or acted upon, even though the information was available.

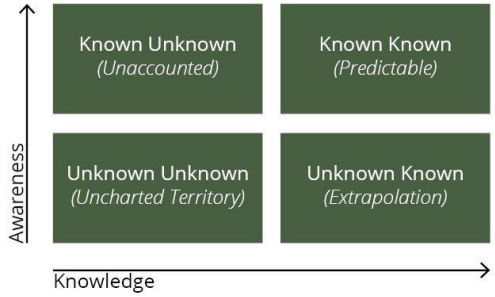


FIGURE 2.2 AWARENESS – KNOWLEDGE MATRIX

Figure adjusted from source: https://www.overops.com/blog/continuous-reliability-handling-known-unknowns-and-unknown-unknowns/

> ***"The amount of cost contingency should be proportionate to the level of uncertainty that the project is subjected to; the higher the uncertainty, the bigger the cost contingency amount."***
>
> ***Hoseini, 2020 (p. 188)***

Besides project specific contingencies, a part of the project budget is often dedicated to unidentifiable risks, 'unknown unknowns'. This is referred to as the management contingency (Lee, et al. 2017) and it used to cover for costs related to major risks, such as the pandemics or catastrophes. This budget is not available for the project, but is managed on a company level. Therefore, it is not included in the diagram in Figure 2.1.

2.2 Cost Contingency Estimates

Every cost estimate made in the budget is an educated guess based on the potentially limited information available at that specific moment (Hoseini 2020). Cost contingencies are difficult to estimate. Like regular cost estimates it is a forecast about the future, which is uncertain (Yeo 1990). In addition, cost contingencies are estimating risks and potential hazards, instead of work packages and tasks, reflecting the financial implications to cope with uncertainties in a project (Mak and Picken 2000) (Anderson, Molenaar and Schexnayder 2007) (Molenaar 2010) (Baccarini and Love 2014). Therefore, various methods and techniques are developed to estimate cost contingency of a project (Yeo 1990) (Mak and Picken 2000) (Barraza and Bueno 2007) (Baccarini and Love 2014) (Hammad, Abbasi and Ryan 2016) (Marco, Rafele and Thaheem 2016). They can be split up into three main categories: deterministic, probabilistic and modern mathematical (Bakhshi and Touran 2014). In Figure 2.3 an overview is illustrated of the common methods.

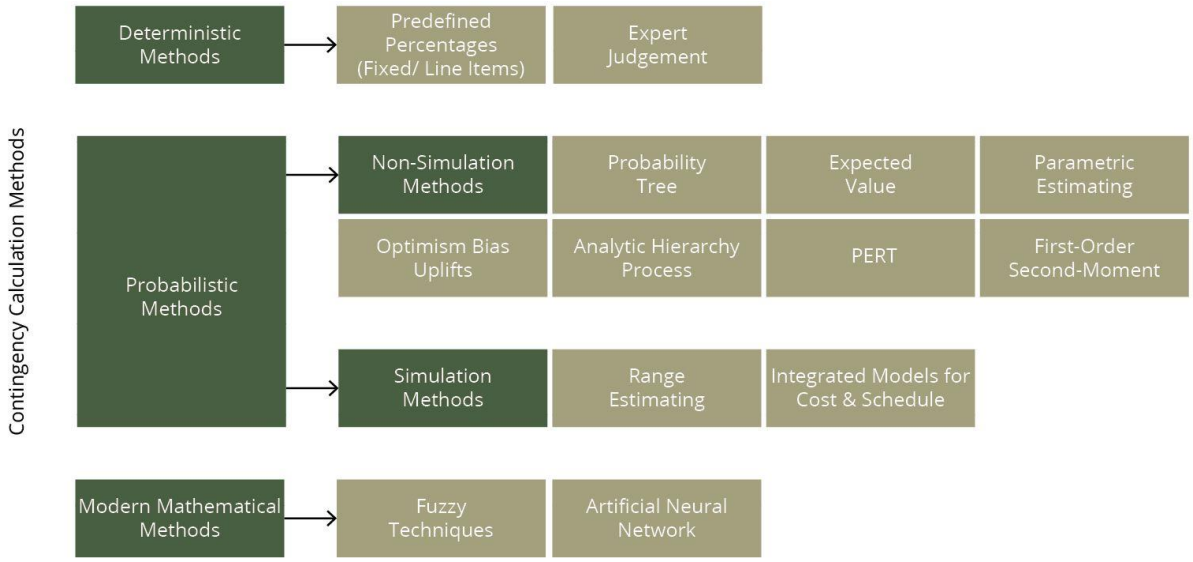


FIGURE 2.3 OVERVIEW OF COST CONTINGENCY ESTIMATION METHODS (ADJUSTED ILLUSTRATION FROM BAKHSHI AND TOURAN (2014))

The methods will not be discussed in great detail. If more detail is needed on a certain method, the paper by Bakhshi and Touran (2014) is recommended for further reading. Below a few, but commonly used methods are highlighted.

2.2.1 Deterministic method - Contingency as a percentage

Traditionally, cost contingency is estimate with deterministic methods. One of them is to include cost contingency as a predetermined percentage of the total project budget (Mak and Picken 2000) (Senesi, Javernick-Will and Molenaar 2015) (Sonmez, Ergin and Birgonul 2007). The percentage is usually derived from intuition and experience (Shane, Strong and Gad 2015) (Lee, et al. 2017). Simple or small projects might suffice with a straightforward method like this one, but in general it has been criticized as arbitrary (Lhee, Issa and Flood 2009) (Cioffi and Khamooshi 2009).

2.2.2 Probabilistic methods

Similar to cost estimates, cost contingency estimates can be determined either deterministic or probabilistic. Instead of using single point estimates from deterministic methods, probabilistic models model uncertainties with statistical distributions (Touran 2006).

"Probabilistic models output which are distributions help the client understand the possible consequences of their decisions where point estimates does [sic] not have this flexibility."

Bakhshi and Touran 2014 (p. 55)

2.2.3 Probabilistic methods – non-simulation – probability tree

In Figure 2.3 a distinction is made between non-simulation methods and simulation methods. A probabilistic non-simulation method includes analytical methods without the use of simulation software packages (Bakhshi and Touran 2014). An example of this method is a probability tree, also known as fault tree, in which individual risks are systematically merged into an overall probability and expected value. The method generates multiple possible outcomes and their consequences.

2.2.4 Probabilistic methods – simulation – range estimate

Analytical models are applicable to small projects and a limited amount of risks. So these methods do not adequately support the complexity and size of large infrastructure projects. Therefore, simulations are used to generate probabilistic output (Bakhshi and Touran 2014). In the construction industry Monte Carlo simulations are commonly used for risk analysis and contingency estimation.

A frequently applied method is Range Estimating. In this method, (cost) items are estimated deterministically, which will be referred to as the 'most likely value'. A maximum and minimum value is attached to the item accordingly to generate a range of possible values. The type of distribution used can differ per item, based on its characteristics. A few examples of commonly used distributions are shown in Figure 2.4. With the help of a Monte Carlo Simulation, the list of items is translated to a cumulative distribution function (CDF). Based on this function, the project team can determine the required cost estimate.

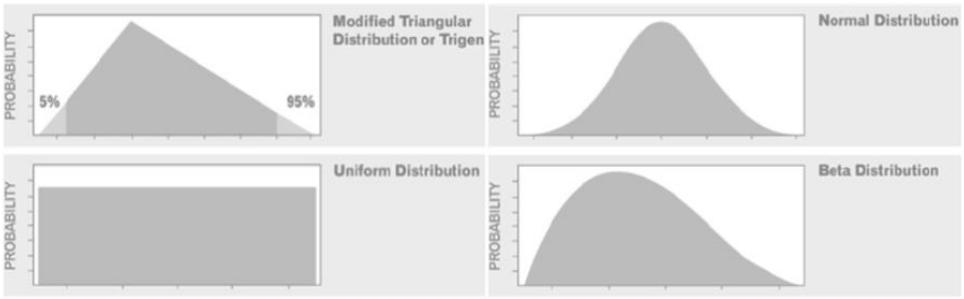


FIGURE 2.4 TYPICAL CONTINUOUS PROBABILITY DISTRIBUTIONS USED IN MONTE CARLO ANALYSIS (HILLSON 2012) (IMAGE FROM (ZACHARIOU 2019))

2.2.5 Modern mathematical methods

The modern mathematical methods are more complex. Both fuzzy techniques and ANN, mentioned in Figure 2.3, are methods that are still being developed and improved. While fuzzy techniques work with words as input and qualitative assessment of risks, ANN needs historical data (old projects) as input for training to eventually generate a cost contingency estimation with project specific data (Bakhshi and Touran 2014). Despite their more accurate simulation of reality than conventional methods, their complexity and demand for data input makes them less popular.

2.2.6 Input for estimates

In the aforementioned methods the input is often based on risks (Cioffi and Khamooshi 2009) (Mak and Picken 2000) (Sonmez, Ergin and Birgonul 2007). However, there are various methods known that use other elements to estimate contingency, for example uncertainty factors (Lhee, Issa and Flood 2009) (Mohamed, et al. 2009) or project characteristics (Veen 2018).

2.3 Cost Contingency Management

Cost contingency estimation is used in the preparation phase of the project, but the budget and the cost contingency needs to be managed too during the project execution. It is common to manage it by applying the same method as the initial estimation, which results in a frequent recalculation of the cost contingency, but the estimation methods do not elaborate on management of cost contingency. Literature on cost contingency management is scarce too (Hammad, Abbasi and Ryan 2016). An overview is provided by Hoseini when summarising management methods in cost contingency (Hoseini 2020, p. 155). These papers were studied and the list of methods was complemented with the management methods found in those papers.

In short, the methods from Barraza and Bueno (2007), Hammad, Abbasi and Ryan (2015) and Hammad, Abbasi and Ryan (2016) are very alike, based on Monte Carlo simulation, assigning cost contingency to project activities. Eldosuouky, Ibrahim and Mohammed (2014) need all project risks to be identified and quantified, and use historical data (from previous projects) to manage earned value. It is similar to Xie, Abourizk and Zou (2011), however, their method does not use risks as input for the estimate or management, but daily actual cost and earnings (based on historical data). Both methods need a lot of data as input. A qualitative method proposed by Gharaibeh (2014) uses the Delphi method to identify issues in project cost control and understand the reasons behind cost overruns. While it was applied post-project execution, it can be applied for cost contingency management, but due to the qualitative research method, using questionnaires, it can be very time consuming. Marco, Rafele and Thaheem (2016) are unique in their approach to cost contingency management by suggesting a system dynamics (SD) contingency management model to simulate the decision-making scenarios. Below the methods are discussed in more detail.

2.3.1 Monte Carlo and Contingency Status

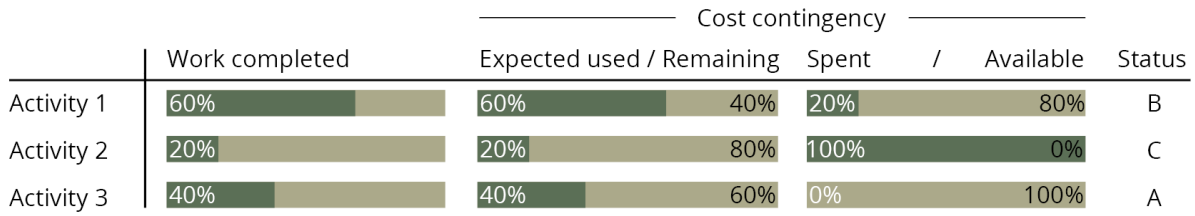
The cost contingency management method from Barraza and Bueno (2007) is based on the principles of Monte Carlo simulation for the initial estimation. Next, the total cost contingency is spread across the project activities and allocated in such a way that all activities are equally likely of a successful performance. During the execution of a project every activity is evaluated based on the concept of earned value method (Anbari 2003), in which the budget, actual costs, percentage work performed and expected costs are used to determine the cost variance. Afterwards, a status is assigned to each activity to reflect the cost contingency used, see Table 2-1. Status A and B are acceptable. In case of an activity with status C, it is advised to negotiate for additional funds. The status can be used as a practical guide for decision making. Contingencies on activity level ‘allows a more efficient management process and corrective action implementation’ (Barraza and Bueno 2007, p. 146), compared to bulk contingency. Moreover, excess cost contingency of one activity should not be used for a negative result of another activity, until the activity is completely finished, because problems with additional funds for future variations are expected.

TABLE 2-1 ACTIVITY STATUS FOR COST CONTINGENCY

Status	Cost variance	Cost contingency	Preferred status
A	Positive	Not used	Ideal
B	Negative, less than cost contingency	Partly used	Acceptable
C	Negative, more than cost contingency	Fully used	Unacceptable

2.3.2 Monte Carlo and Contingency Status Improved

Hammad, Abbasi and Ryan (2015) updated the method from Barraza and Bueno with the goal to generate more decision making information to the project manager. Besides the status of each activity, the actual remaining contingency is reported to the project manager too. "The expected remaining contingency is calculated by assuming that the amount of contingency spent is directly proportional to the percentage complete of each activity" (Hammad, Abbasi and Ryan 2015, p. 5). With this the cost overrun can easily be traced back to a specific activity, which is valuable information for the project manager. An example of all three status are given in Figure 2.5.



The work completed is proportional to the expected cost contingency used. The expected remaining contingency (in the middle column) is derived from the expected cost contingency used and is compared to the actual cost contingency available to determine the status.

FIGURE 2.5 EXAMPLE ACTIVITY COMPLETION, COST CONTINGENCY AND ITS STATUS

2.3.3 Activity's Contribution to Cost Variance

Hammad, Abbasi and Ryan (2016) continued developing their method for cost contingency management and published a paper about it a year later. They skipped the idea of allocating a status to the activities, but the basic concept stayed the same: cost contingency estimation based on Monte Carlo and individual activities. However, in this method the activities are not assumed to be equally contributing to project success. Therefore the total cost contingency is proportionally allocated to the activities that contribute to the overall cost variance of the project. This means that an activity with high uncertainty, high costs or that lies on the critical path has a larger contribution to the cost variance and for that reason will receive a higher share of the total cost contingency. For cost contingency management the remaining cost contingency is checked and compared to the initial contingency, which reveals cost overruns or underruns, and critical activities. Additionally, the cost contingency is recalculated. This type of management is based on past and current spending patterns, and is adaptable to disruptions in the project environment, as the confidence interval can be altered by the project manager. The main benefits are that no large amounts of (historical) data are needed, neither are expertise and knowledge about complex software or techniques, like fuzzy, ANN, logic or other simulations. But most importantly, recalculating the cost contingency for unfinished activities based on the ongoing pattern of spending can tell if activities are going to go over budget.

2.3.4 Earned Value Management

Eldosouky, Ibrahim and Mohammed (2014) developed another method for monitoring and managing cost contingency. Earned value management is also based on risk analysis and uses Monte Carlo simulation to determine the cost contingency, however there are some additional elements included in this method that distinguishes it from other methods. The estimates are valued with a percentage, reflecting the confidence in the estimate. Additionally, a performance measurement baseline is composed and managed, which consists of project base cost (direct and indirect costs), uncertainty budget and mitigation costs. Besides there is a so-called 'management reserve' consisting of 'specific risks' and 'non-specific risks'. Translating these definitions to the vocabulary used in this thesis the second budget would be called a cost contingency used for all risks, but estimated based on a Monte Carlo simulation of the identified risks. This method is dependent on extensive collection of data from previous projects and subjective expert judgement. The research stresses the importance of including opportunities, as it can balance out with emergent risks during the project execution phase.

2.3.5 Value at Risk

Xie, Abourizk and Zou (2011) recognised practical problems in identifying and quantifying potential risks, which makes it difficult to perform a thorough risk analysis to determine cost contingency. Therefore, their method does not use risks as input for the estimate or management, but daily actual cost and earnings. This way, all risks are included in the method, identified (known unknowns) and unidentified (unknown unknowns). The simulation is executed on the basis of historical data from previous projects, and produces a statistical measure of the expected maximum loss, with a certain probability over a specific time. With a selected time horizon and confidence level the 'value at risk' can be determined at any time during project execution. The disadvantage of this method is that a lot of data is needed to be reliable.

2.3.6 Delphi method

Gharaibeh (2014) applied the Delphi method to construction projects to identify problems with project cost control. This is classified as a reactive process, because it evaluates cost overruns that already happened, while other management methods proactively try to prevent cost overruns. Nevertheless, by evaluating minor cost overruns in the beginning of the project execution phase, future cost overruns can potentially be anticipated or avoided. The Delphi method entails time consuming questionnaires to gather the knowledge from experts.

2.3.7 Decision Making Scenario Simulation

Marco, Rafele and Thaheem (2016) are suggesting a different method for cost contingency management, which is able to include project dynamics and other factors influencing risk and cost contingency management processes. It simulates decision-making scenarios, with different parameters such as project conditions and behavioural pressures of key actors of the process. The research is focussed on the release process of cost contingency, while the actual management of the risks and cost contingency is barely touched upon. Nevertheless, it is a unique perspective on the cost contingency management process and a valuable contribution to literature.

2.4 Accurate Estimate

Concluding from the previous paragraphs, the cost estimates and especially the cost contingency estimate should be very accurate. When it does not suffice to complete the project, cost overruns will occur. However, including large buffers on top of the estimates will lower the chances of winning the tender and getting the project assigned (Sonmez, Ergin and Birgonul 2007) (D. Y. Kim 2008) (Hammad, Abbasi and Ryan 2016). Accuracy in the cost estimates helps the contractor to develop a budget that is low enough to be the lowest to get the project assigned, but high enough to prevent cost overruns and ensure a profit (D. Y. Kim 2008).

> *"Inaccurate estimation of the costs is named as one of the most frequently identified causes of project overrun."*
>
> ***Hoseini, 2020 (p. 186)***

An accurate cost estimate is of high importance for project control (Yeo 1990) (Mak and Picken 2000) (Uzzafer 2013) (Baccarini and Love 2014) (Hammad, Abbasi and Ryan 2016), (Hoseini 2020). Furthermore, it can increase project success, when estimates are accurately determined and carefully managed (Baccarini 2004) (Olawale and Sun 2015).

> *"Perfect budgeting of the risk reserve means no individual differences and thus a perfect correlation between budgeted and required risk reserves."*
>
> ***Veen 2018 (p. 98)***

An estimate is accurate when it is equal to the actual cost required at the end of the project. However, it is extremely difficult, and not necessary to estimate so precisely. For example, when the project costs €15.000.050 and the budget was estimated at 15 million euros, the additional cost of €50 (only 0.0003% of the total budget) is acceptable. Therefore, the estimate is considered accurate enough.

"While most of the current literature deliberates on the accuracy of a cost estimate, in general, studies into the accuracy of cost contingency are scarce" (Hoseini 2020). However, the concept of accuracy can be explained by Figure 2.6. In this figure accuracy is depicted as the deviation from the actual value. However, it should not be confused with precision. Precision is related to the aforementioned distributions to express uncertainty in an estimate. Figure 2.6 illustrates clearly how the width of the distribution affects the precision of the estimate. A wide distribution represents a vague estimate, while a narrow distribution implies a precise estimate.

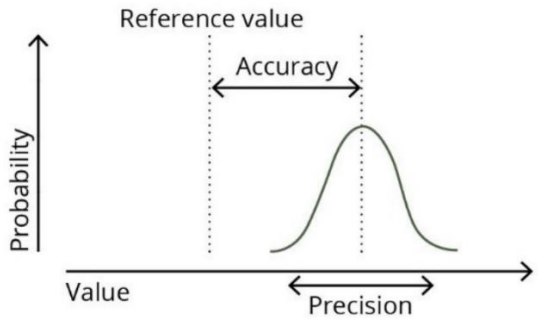


FIGURE 2.6 ACCURACY AND PRECISION IN A STOCHASTIC VARIABLE (ADJUSTED ILLUSTRATION FROM VEEN (2018))

In section 2.2 'Cost Contingency Estimates' probabilistic methods for cost contingency estimation are discussed, using Monte Carlo simulation. This method generates a cumulative distribution function (CDF) as depicted in Figure 2.7.

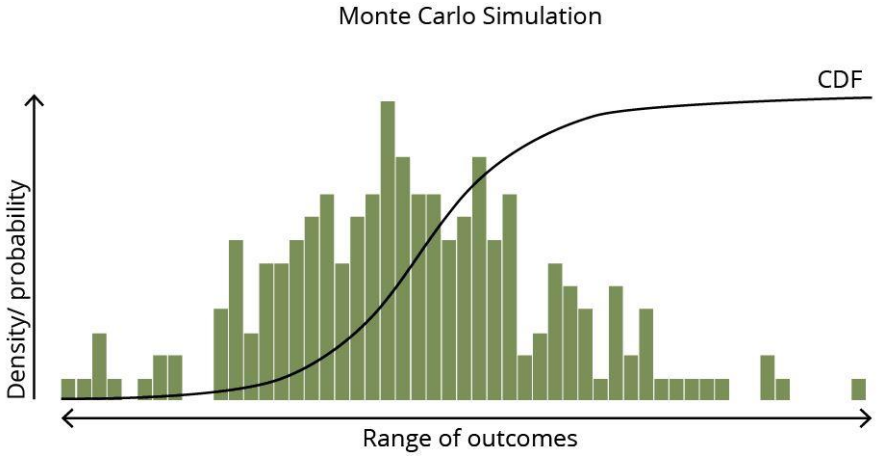


FIGURE 2.7 CUMULATIVE DISTRIBUTION FUNCTION - MONTE CARLO SIMULATION

The horizontal axis represents possible costs and the vertical axis shows the frequency of the project costs. With this graph the project team can decide which cost contingency they include in the budget. This is commonly done with predetermined confidence intervals. These intervals represent a certain area under the graph, corresponding with a probability of occurrence. For example, Figure 2.8 shows a dotted line at the confidence interval of 0.8. This indicates that the cost corresponding to this point at the graph (on the horizontal axis), for example €20 million, would suffice to complete the project 80% of the times in this simulation. The lower the confidence interval, the more risk is accepted, and the higher the confidence interval, the more likely the project will stay within the limits of the budget. 80% is a common confidence interval for cost contingency based on risks (Bakhshi and Touran 2014). However, different sectors, companies or professionals can have their specific confidence intervals for certain calculations.

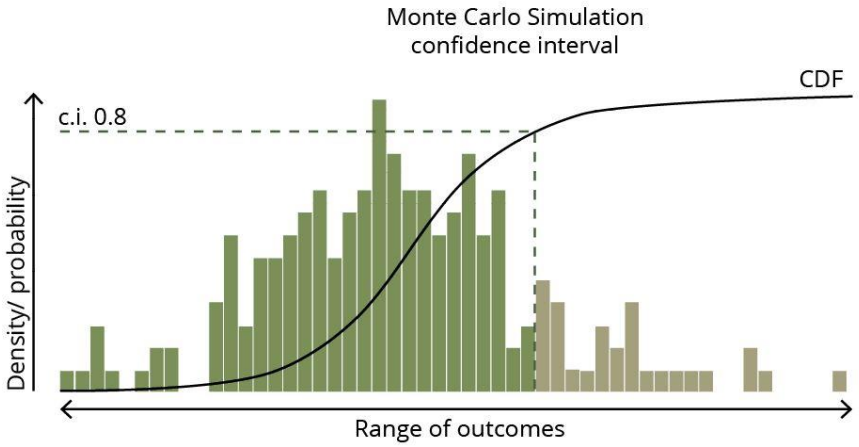


FIGURE 2.8 CUMULATIVE DISTRIBUTION FUNCTION AND THE CONFIDENCE INTERVAL

Eventually, the accuracy of an estimate can be examined at the end of a project, when the actual costs are known. Even though margins of error and confidence intervals are applied, an inaccurate estimate according to those definitions is not always problematic. For example, the goal of a project is to achieve the project objectives. If those are met, but the project exceeds its initial budget, it can be argued that the project is still successful. Especially, when the changes throughout the project are financed by the client. This happens frequently when the scope of the project is too narrow to fulfil the project's objectives. Additionally, the project can change the design, execution techniques or materials, resulting in deviations in the costs. These type of deviations are expected and acceptable (Hoseini 2020).

2.5 Challenges to Overcome to Achieve Accuracy in Cost Contingency Estimates

Despite the necessity of accuracy in cost estimates, it is hard to achieve it. In the following paragraphs the possible causes are discussed.

2.5.1 Poor Practice and Uncertainty

The most straightforward reason for not achieving accuracy in estimates is poor cost estimation and management practices (Shane, Strong and Gad 2015) due to, for example, inexperience of the project manager or limited skills available. Similarly, inaccurate cost estimations can also be a result of poor communication between design and construction project teams, and the stakeholders (Shane, Strong and Gad 2015). Besides, contractors strive for efficiency in resources, for example, to minimize costs. In reality, people might work less efficient or waste is produced due to other reasons, which can cause cost overruns (Brunes 2015). This makes it difficult to estimate material costs accurately. Furthermore, project teams of projects with high uncertainty have a tendency to include a large amount of cost contingency, because they are not confident in their estimates (Hoseini 2020). In literature this is often referred to as pessimistic bias (Hoseini 2020).

2.5.2 Project Specific

Other challenges to overcome are more related to the project itself. First of all, project dynamics influence perception of cost contingency. As the project progresses and milestones are achieved, work packages are completed, the project is subjected to less uncertainty (Xie, AbouRizk and Zou 2011). Likewise, in the tender phase, when the cost contingency is estimated, there is uncertainty about the project details and it is challenging to predict how it will advance (Hoseini 2020). Additionally, Van Veen (2018) conducted a research about realised project costs and cost contingency and concluded that project characteristics, such as project size, knowledge of the initial assets, project preparation, stability of initial project scope and project duration, have a significant influence on the required cost contingency.

2.5.3 Strategic Misinterpretation

The final type of challenges are strategic misinterpretations of the cost contingency estimate. In this case the project team or manager is aware of the amount of cost contingency needed, but deliberately chooses to include a different value, either higher or lower than estimated. The most common phenomenon causing inaccuracy in cost estimating is optimism bias (Kahnernan and Tversky 1977) (Flyvbjerg, Holm and Buhl 2002) (Lovallo and Kahneman 2003) (Flyvbjerg 2006) (Liu and Napier 2010). It happens when the cost contingency included in the budget is lower than the initial estimate, in order to get approval for the project (Flyvbjerg, Holm and Buhl 2002). As this is not a systematic error, it is likely to keep causing problems in achieving accuracy in cost contingency estimation (Flyvbjerg 2006). This optimism bias is not always voluntarily behaviour. Market conditions and the amount of contractors competing for a project can force contractors to be optimistic about risks and lower the cost contingency estimate in an attempt to win the work (Liu and Napier 2010) (Jung and Han 2017).

Other strategic misinterpretations can be caused by organizational behaviours (Hoseini 2020). The ability to estimate cost contingency accurately is influenced by incentives or the reporting environment of the organization (Grau, Back and Mejia-Aguilar 2017). Client's organizations are often risk avoidant and have a tendency to include extra reservations in the budget, because they want to avoid reputation damage and public critics (Hoseini 2020).

2.6 Improve Accuracy in Cost Estimates

Errors in cost contingency estimates resulting from uncertainties are systematic errors, and are likely to improve over time (Flyvbjerg, Holm and Buhl 2002). This improvement is assumed due to the recognition of the deviated estimate during the project, so it can be addressed and improved, while better methods are developed and experience is gained (Flyvbjerg, Holm and Buhl 2002). Revising the initial cost contingency estimate is recommended (Xie, AbouRizk and Zou 2011).

Non-systematic errors, such as optimism bias are frequently the result of the 'inside view' (Veen 2018). This can be improved by revising the project with an 'outside view' (Kahnernan and Tversky 1977). This is referred to by other authors that researched cost estimating. They imply to produce a more realistic estimate with this 'outside view' as it is based on reference projects or other types of historical data, or experts from outside the project (Lovallo and Kahneman 2003) (Liu en Napier 2010) (Hoseini 2020). Especially historical data from previous projects is recommended regularly in literature to improve the accuracy of cost (contingency) estimates (Lovallo and Kahneman 2003) (Flyvbjerg, Skamris Holm and Buhl 2005) (Flyvbjerg 2006) (Liu en Napier 2010) (Hoseini 2020).

However, risk documentation is limiting research and understanding of critical risks, contingencies and cost overruns. Risks and cost overruns are often documented in project specific cost components, rather than the destined cost contingency or allowances (Veen 2018). Improving the consistency in cost documentation can contribute to identifying critical risks quantitatively and to improve accuracy of the needed cost contingency (Veen 2018).

2.7 Main Thrust

The budget is composed of multiple components. The base estimate can be split into direct costs and indirect costs with additional allowances to cover for lack of scope detail. Contingencies are added to the budget to account for uncertainties and fluctuations by external factors affecting the project. Cost contingency is specifically included in the budget to account for risks and unforeseeable situations within the scope of the project and it should be proportionate to the level of uncertainty of the project. Other types of contingency, such as management contingency, will not be discussed in this research, because it is not a project specific uncertainty and cannot be accessed by the project team without approval from higher levels of interproject management. Escalation will also not be included in this research, as these external, financial factors (e.g. market conditions and inflation) are not related to risk management and cannot be controlled or managed.

The amount of cost contingency is estimated in the preparation phase of the project. Various methods are available in literature to estimate cost contingency, and they can be divided into three main categories: deterministic, probabilistic and modern mathematical methods. The most commonly used method is range estimating, a probabilistic method using Monte Carlo simulation to calculate the contingency needed. During the project the cost contingency is managed. Usually, the cost contingency is recalculated with the estimation method from the preparation phase. There is limited research about cost contingency management methods. Some methods are not practical, due to the excessive amount of data needed from

previous projects (Xie, AbouRizk and Zou 2011) (Eldosouky, Ibrahim and Mohammed 2014). Other reasons for making the methods less applicable in practice are time consuming methods like Delphi (Gharaibeh 2014) or considerable amount of knowledge about complex simulations or programming needed for some methods (Marco, Rafele and Thaheem 2016). The most promising and applicable methods for cost contingency management are based on risks, project activities and Monte Carlo simulation (Barraza and Bueno 2007) (Hammad, Abbasi and Ryan 2015) (Hammad, Abbasi and Ryan 2016), because they are relatively easy to execute and issues can be traced back to specific project activities. Moreover, some methods are based on risk analysis, which results in a cost contingency based on identified risks ('known unknowns'), while the unidentified risks or unforeseen circumstances are often also managed or compensated from the cost contingency budget, meaning the estimate does not include nor suffice the total use of the cost contingency. This distinction will be evaluated in the case studies.

Development of cost contingency estimation methods is acknowledged (Mak and Picken 2000) (Barraza and Bueno 2007) (Baccarini and Love 2014) (Hammad, Abbasi and Ryan 2016) (Marco, Rafele and Thaheem 2016) (Kim and Pinto 2019). However, the development and availability of methods and techniques to estimate cost contingency does not significantly contribute to improved cost estimating in construction projects (Flyvbjerg, Holm and Buhl 2002) (Lovallo and Kahneman 2003) (Hollman 2012) (Khamooshi and Cioffi 2013) (Baccarini and Love 2014) (Gharaibeh 2014) (De Marco, Rafele and Thaheem 2015) (Marco, Rafele and Thaheem 2016): projects still suffer from cost overruns (Pinheiro Catalão, Oliveira Cruz and Miranda Sarmento 2019). The gap between literature and practice will be taken into account when executing this research, and it will be discussed in the conclusion and recommendation section.

Methods for estimating and managing cost contingency are developed to increase accuracy of the cost contingency. For contractors specifically, it is of high importance to have an accurate cost contingency estimate, because the lowest bidder gets the project assigned[1]. However, a tight budget increases the risk of cost overrun. Therefore, cost contingency is carefully estimated. The confidence interval is selected in such a way that the project team is confident about realising the project within the set budget, because it is unfeasible to include all uncertainty in the budget. When the project is finished, the actual costs can be compared to the initial estimate to determine the accuracy. Therefore, finished projects will be used in this research.

In literature the reasons for inaccuracy of cost contingency have been examined. It can be concluded into three types of challenges that are encountered in the estimation process: poor practice and uncertainty, project characteristics and dynamics, and strategic misinterpretations. These categories will be considered in this research to explain the practical challenges at Dura Vermeer. Improving the accuracy of cost contingency estimates due to systematic errors is assumed to improve over time when management of cost contingency is adequately implemented. Improvement due to non-systematic errors can be achieved by taking an 'outside view' by using historical data, or external experts as reference for the estimates. Additionally, risk and cost documentation should be improved to supply this historical data, and on the other hand contribute to better risk and cost contingency research. The suggested improvements in literature will be compared with the current processes of Dura Vermeer.

[1] Technically, it is incorrect to state the lowest bidder gets the project assigned. Current practice applies 'EMVI' to value the project plans, which is more complex, but not very relevant to this research. With this method the quality of the plan is considered and discounted in the total price of the offer. It results in a 'virtual price' that includes both quality and price, and the economically best alternative scores best.

3 Early Warning Signs

3.1 Leading and Lagging Indicators

Traditionally, performance indicators, such as cost, quality and scope, of projects are monitored to express the progress and success of a project. These indicators provide information on past events or activities (Haji-kazemi 2015). For example, the consequences of an event can be expressed in money, consequently, it is reflected in the cost performance indicator. Traditional performance indicators function as lagging indicators (Wijtenburg 2018).

On the other hand, leading indicators can provide more relevant information (Williams, Jonny Klakegg, et al. 2012) and allow for proactive management of projects (Haji-kazemi 2015), as they present themselves before the issue happens. Some examples are employee satisfaction, project team expertise and stakeholder relations (Choi 2007), (Haji-kazemi 2015). Even though there is a need for proactive project management (Haji-kazemi 2015) and leading indicators are occasionally applied in construction projects (Chan, Chan and Chan 2004), current project management methods do not include leading indicators (Wijtenburg 2018).

3.2 Definition Early Warning Signs

An early warning sign is a concept that presents itself in the form of an observation, message, sign or other indication, which suggests an approaching future positive or negative issue (Nikander 2002). This early warning sign is an indicator for future events, and when acted upon, potential future negative events, like risks, can be mitigated (Wijtenburg 2018).

In literature early warning signs are also applied to risk management, but are often referred to as risk symptoms. The observation of an early warning sign is associated with the potential presence of a risk (PMI 2008). However, there is a clear difference between risk management and early warning signs, as early warning signs only suggest a potential risk event will materialize, while risks provide more information about the probability, time frame and impact (Haji-kazemi 2015). Therefore, early warning signs solely function as an alarm, which triggers action to prevent materialization of the potential risk or diminish the consequences of the risk (Haji-kazemi 2015).

As mentioned before, early warning signs can take different forms. In literature examples of early warning signs are discussed and categorized to form a better understanding of the concept. Some examples are warnings expressed by personnel or project team, project control, communication, documents and reporting, the project manager, management and managerial style, trust within the team, workload and opportunity and attention for reflection (Nikander 2002), (Wijtenburg 2018).

3.3 Application in Construction Industry

The application of early warning signs in the construction industry to manage projects or mitigate risks is known in literature (Williams, et al. 2012), (Haji-kazemi 2015), (Othman, et al. 2018), (Bhattad 2019), but still relatively new and difficult to apply in practice (Wijtenburg 2018). Furthermore, this concept is often used in the context of safety in the construction industry (Biggs, et al. 2010), (Lingard, et al. 2017), (Shrestha, et al. 2020). Therefore, the synonym lead (safety) indicator is frequently used.

3.4 Responding to Early Warning Signs

Responding to early warning signs has been proven to have a positive effect on project performance and problem solving (Meng 2014). Although companies and project teams are aware of the presence of early warning signs, they fail to respond to them (Haji-Kazemi, Andersen en Klakegg 2015). In literature, this is explained by the presence of filters and barriers, which block the identification and response to early warning signs (Williams, Jonny Klakegg, et al. 2012).

Three filters are identified in literature: surveillance filter, mentality filter and political/ power filter (Ansoff 1984). The first refers to the collection and management of information, the second represents the personal judgement of the receiver of the information and the last one signifies the decision-making process of the organization or project team. An early warning sign must pass all filters before the project team can respond (effectively) to it (Haji-kazemi 2015).

Besides these filters, project teams experience barriers that limit their response to early warning signs. According to a study by Wijtenburg (2018), the eight most important barriers are optimism bias, time pressure, project complexity, uncertainty avoidance, fragmentation, client-contractor relation, political effects and management style.

3.5 Identification Methods of Early Warning Signs

Filters and barriers are difficult to overcome. However, there are some methods developed in literature to assist in identifying early warning signs. The following list is composed by Haji-Kazemi, Andersen and Krane (2013), based on literature and experiences from industrial case studies, and consists of methods as a source for detecting early warning signs.

- Risk analysis
- Earned value management
- Project review assessment
- Performance measurement data
- Stakeholder analysis
- Analysis of brainstorming data
- Maturity assessments
- Analysis of previous projects
- Cause-and-effect analysis
- Gut feeling
- Interface analysis
- Analysis of project characteristics
- External factors

In the paper by Haji-Kazemi, Andersen and Krane (2013) they evaluated all methods. Based on their assessment two methods are selected for this research. Risk analysis was selected as a method, because it is does not need (much) additional data. Moreover, risks are documented very well during all project phases, and this data is still available after project completion. Many methods did not suit the purpose of this research as it requires many resources, for example stakeholder analysis, or interventions that had to be done during project execution, such as performance measurement, brainstorming and gut feeling. Additionally, cause-and-effect analysis is selected to be applied in this research, because it focusses on early triggers of undesired events and it can be combined easily with the risk analysis method.

Identification methods found in literature mostly focus on hard factors as early warning signs, for example, documentation, contractual obligations and milestones (Williams, Jonny Klakegg, et al. 2012), (Haji-Kazemi, Andersen and Krane 2013). However, some early warning signs are equally important, but cannot be found with assessments (Williams, Jonny Klakegg, et al. 2012). These weaker and softer signals can be detected by listening very closely to the environment (Nikander 2002), unofficial discussions, like coffee corner talks (Holopainen and Toivonen 2012), stakeholder engagement tools or employee feedback surveys (Williams, Jonny Klakegg, et al. 2012).

3.6 Main Thrust

Project teams monitor performance indicators, which are lagging indicators providing information about events or activities that happened in the past. It contributes to the learning process, but it does not contribute to proactive management. Leading indicators can function as early warning signs, presenting themselves before the issue arises. Acting upon these signs, e.g. by taking mitigating measures, can reduce the probability or impact of a (risk) event. Early warning signs can contribute to project performance if the response is effective. However, in identifying and responding to early warning signs, there are filters to overcome limiting the flow of information and decision-making. Additionally, barriers are experienced, such as optimism bias, time pressure, project complexity, uncertainty avoidance, fragmentation, client-contractor relation, political effects and management style.

There are multiple methods for project assessment to identify early warning signs. However, these are mostly skewed towards hard early warning signs. To detect soft early warning signs other methods, like stakeholder feedback or informal discussions, can be applied. For this research a combination of the two approaches will be used to identify the early warning signs. As risk management is the focus of this research, that method will be selected, along with a cause-and-effect analysis. The soft early warning signs will be detected via interviews with the risk managers of the project.

EMPIRICAL STUDY

4 Processes at Dura Vermeer (Landelijke Projecten)

In the preceding chapters the theoretical perspective on budget, cost contingency and early warning signs is discussed. This will be compared to the processes at the construction company Dura Vermeer to reflect on the translation from literature to practice and to explore the context of the case studies. Dura Vermeer has multiple divisions. This research was executed at the 'Werkmaatschappij Infra Landelijke Projecten'. The processes analysed in this section derive from this division and might differ from processes elsewhere in the company. The following components will be analysed: the budget, cost contingency estimation and management method, and early warning signs.

4.1 Budget

The structure of the budget at Dura Vermeer is different from the budget in literature, but contains more or less the same components. The main elements of the theoretical budget are combined with the budget composition of Dura Vermeer in Figure 4.1. The most remarkable difference is that literature clearly defines the base estimate, with contingency and escalation components on top, while Dura Vermeer does not make such a distinction. Their 'base estimate' are the direct costs from materials, labour, equipment, etc. and indirect costs, including overhead, contingency and reservations are added later in the budget. While literature considers site costs to be direct costs, Dura Vermeer categorises it as indirect costs. Moreover, Dura Vermeer combines 'contingency', 'allowances' and 'escalation' from literature into a component of indirect costs called 'risks and opportunity'. Additionally, Dura Vermeer has a cost component which is not based on the scope of a project, and therefore not mentioned in the theoretical budget in Figure 2.1. The reservation accounts for non-project specific costs, such as general costs, profit and unaccounted risks (unknown unknowns).

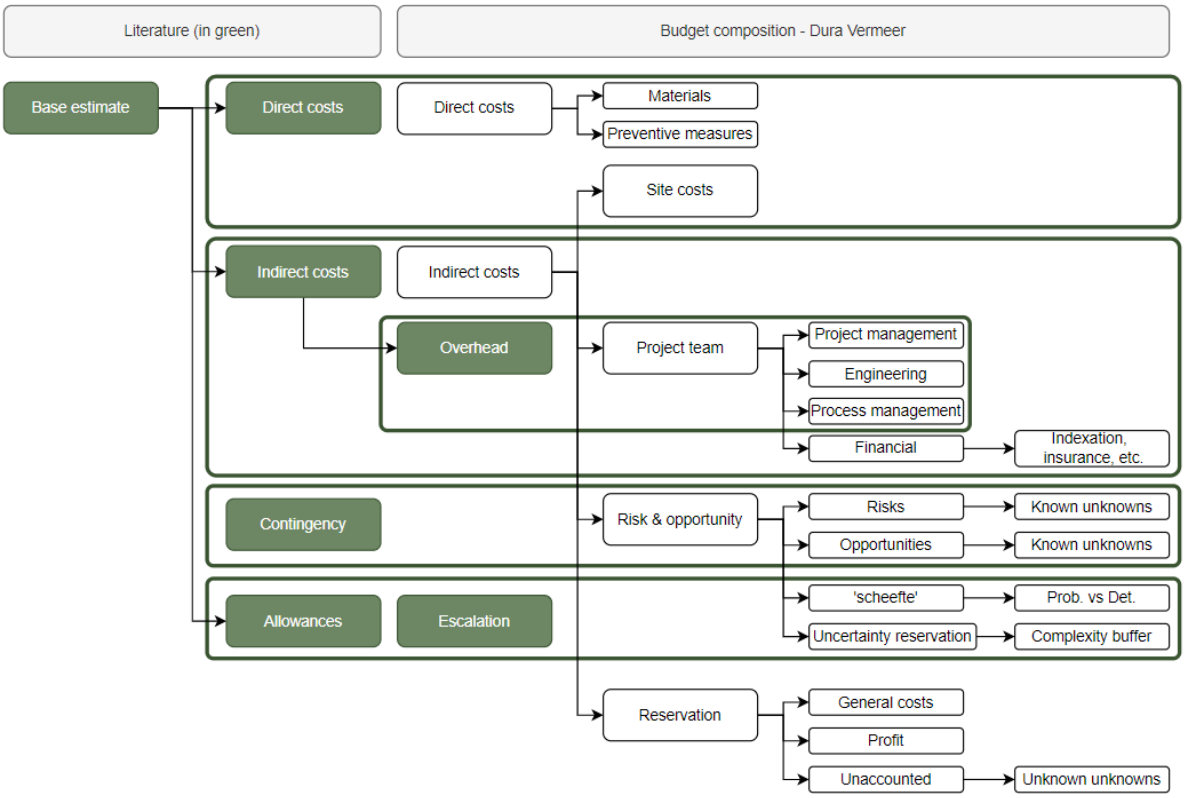


FIGURE 4.1 COMPARISON BUDGET STRUCTURE FROM LITERATURE (GREEN) TO PRACTICE AT DURA VERMEER

The main differences between Dura Vermeer and literature highlighted in the previous paragraph can be explained by the roles of client and contractor. In general, contractors need more contingency and reservations to cover for uncertainty and unexpected costs, because they can go bankrupt if projects seriously fail. Clients, on the other hand, often compose their budget from governmental means and shift money across projects to level the overall outcome. Hence, the theoretical budget discussed in paragraph 2.1 includes project specific costs and contingencies, while excluding reservations.

The budget structure of Dura Vermeer will be discussed in more detail and is illustrated clearly in Figure 4.2. The elements in the figure and the explanation are based on official internal documents from Dura Vermeer and verified with a cost expert.

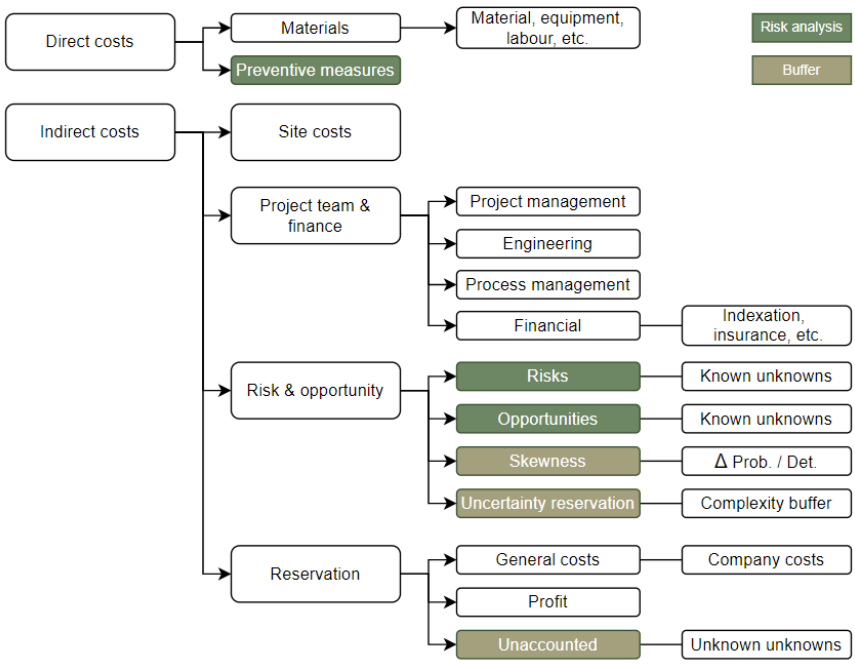


FIGURE 4.2 BUDGET STRUCTURE DURA VERMEER OF LARGE INFRASTRUCTURE PROJECTS

The direct costs, site costs and project team costs are straight forward costs and will not be elaborated upon. The last category of indirect costs, 'reservation', contains mostly non-project specific components. Additionally, the cost component 'unaccounted' is implemented to compensate for any negative results in the budget during the project, but is under the supervision of the project manager or director.

The most interesting category of this budget is 'risk & opportunity' and is often referred to as risk reservation or cost contingency. Here the project specific contingency is allocated. Risks and opportunities (in Figure 4.2 in dark green) are determined based on a risk analysis and reflect the known unknowns of the project. Additionally, two other analyses are made to compose the total cost contingency. Direct costs are determined deterministically in the first section of the budget, but a probabilistic calculation is made too, which is reflected in the skewness. Skewness is the difference between the deterministic price (most likely costs) and probabilistic price (expected value). Additionally, a third estimate is done to compose the entire 'risk & opportunity' budget. The uncertainty reservation is increased as the complexity of the project increases, the scope is inadequately known or there is a lack of confidence in the accuracy of the estimates. Therefore, the inclusion of uncertainty reservation in a budget is dependent on these factors and not always present in every project budget.

Cost contingency in this budget is composed of multiple elements. 'Risks' and 'opportunities' are based on risk analysis and are usually well-documented during the project execution. 'Skewness', 'uncertainty reservation' and 'unaccounted' are deduced from other types of analysis, which are mainly based on expert judgement and company guidelines. For example, 'unaccounted' is usually 2-3% of the total budget. Despite the interest in these components, collecting data and information about it will be extremely difficult, if not impossible. Therefore, the scope of this research is limited to 'risks' and 'opportunities'.

4.2 Cost Contingency Estimation

With the structure of the budget in mind, the cost contingency estimation method of Dura Vermeer was analysed. The information in this section has been extracted from internal documents (e.g. 'Strategie Risicomanagement in tenders (v1.0)' and 'Werkinstructie Budget- en Kostenbewaking'), which describe the processes and has been verified with several risk managers from Dura Vermeer. There is a clear distinction between two types of cost contingency within the budget. The first type is the method for determining the base estimate with a probabilistic method, to include inherent variability. This part will be explained in the following section, but will not be considered as cost contingency in the remainder of this empirical study. The other type is the cost contingency based on risk analysis. This is reflected in the budget under 'risks' and 'opportunities' and will be discussed thoroughly.

4.2.1 Distribution Estimates for Base Estimate

A common method to make realistic cost estimates is to use triangular distributions instead of single values for the estimate. This probabilistic method produces more realistic values than single values from a deterministic method. The triangular distribution applied at Dura Vermeer for direct, site and project team costs is based on the PERT method, which assigns 3 values to each cost element: pessimistic, optimistic and most likely value. The most likely value is at the peak of the distribution (highest probability) and the optimistic and pessimistic values define the bandwidth or range of the possible costs. An example of 3 cost elements with their estimates are visualised in Figure 4.3.

	Pessimistic	Most likely	Optimistic value
Cost 1	€ 60	€ 50	€ 20
Cost 2	€ 30	€ 25	€ 20
Cost 3	€ 90	€ 60	€ 30

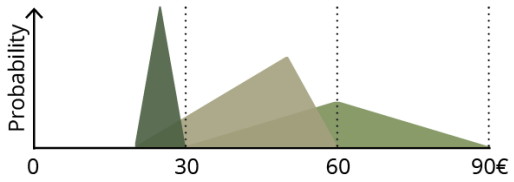


FIGURE 4.3 PERT COST ESTIMATES – INPUT VALUES (LEFT) AND PROBABILITY DENSITY FUNCTIONS (RIGHT)

Subsequently, all cost distributions are entered into a Monte Carlo simulation, which generates a distribution of outcomes. As discussed in the literature chapter, from this distribution a certain value is selected to represent the total costs, based on the confidence interval set by the project team. At Dura Vermeer, they often aim for a confidence interval of 85% (P85), which represents the value that is sufficient to cover the costs in 85% of the simulations. The higher the confidence interval, the more contingency is included in the budget.

4.2.2 Cost Contingency from Risks

The second element of cost contingency at Dura Vermeer's project budget is extracted from a thorough risk analysis. The method is similar to the above mentioned PERT method, but applied to risks instead of cost elements. When compared to literature, it belongs to the category of probabilistic methods, using simulation (Monte Carlo) in range estimating from Bakhshi and Touran's (2014) categories as described in section 2.2 'Cost Contingency Estimates'.

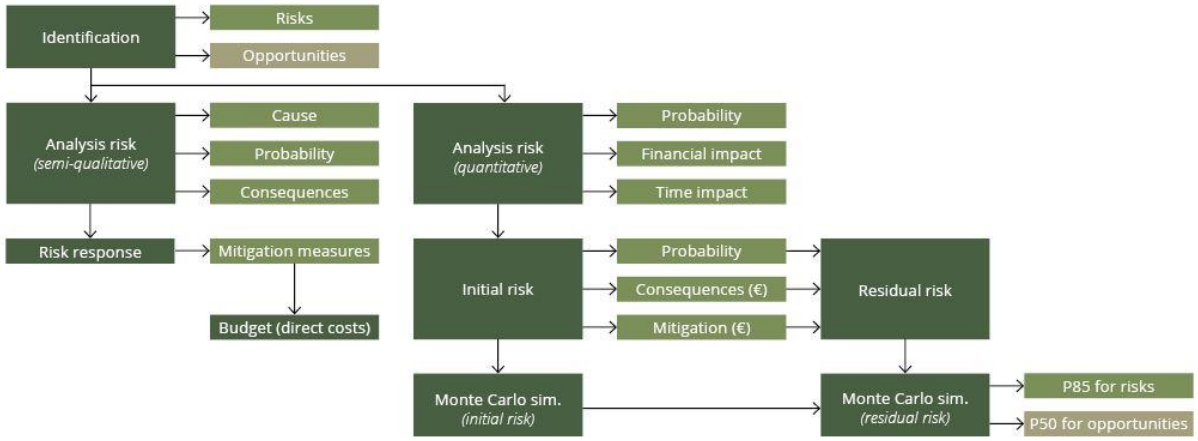


FIGURE 4.4 COST CONTINGENCY ESTIMATION BASED ON RISKS

The process steps taken to determine the cost contingency based on risks is visualised in Figure 4.4. First, risks and opportunities are collected via experts and brainstorming. Then the risks are semi-qualitatively analysed to address their causes, probability and consequences, which is explained in more detail in the text box on the right. Afterwards, a risk response is formulated for the major risks. This results in a list of mitigation measures to reduce the risk (probability and/or impact), which are included in the base estimate's direct costs. A residual risk value is composed to show the anticipated effect of the mitigation measure.

From this risk and opportunity register, a quantitative analysis is performed to determine the quantitative impact of the risks expressed in time (with Oracle Primavera Risk Analysis) and money (with @Risk). In the first iteration of Monte Carlo simulation the initial risks are used as input. This will be used as a reference value. For the second simulation the residual risks are used, producing a distribution of possible outcomes. When risks are used as input the P85 value is selected, which means that in 85% of the simulations this amount of cost contingency was sufficient. For opportunities, the process is the same, but a more conservative value, P50, is selected.

In practice risks are assessed individually. Sometimes a bow-tie diagram is created for complex or major risks to map the causes and effects of that specific risk. However, this is done separately for every risk of interest.

Risk Quantification

The identified risks and opportunities are analysed and assessed with a semi-quantitative scale. In Table 4-1 an example is given from a project at Dura Vermeer. The scale per probability of consequence vary from 0 to 5, but each step is described with a range. For example, a risk with an estimated chance of 20% gets the classification 3 for probability. And when the impact is a delay of 3 weeks and 400000 euros of additional costs, the risk will be classified with a 2 for time impact and 3 for financial impact.

TABLE 4-1 RISK ASSESSMENT EXAMPLE SEMI-QUANTITATIVE (SOURCE: DURA VERMEER: VECHTDAL VERBINDING TOP 20 RISICO'S - ACTUELE KWANTIFICERING NIEUW)

Kans
0| 0 %
1| 0 - 3 %
2| 3 - 10 %
3| 10 - 25 %
4| 25 - 50 %
5| > 50 %

Gevolg geld	Gevolg tijd
0| 0 Euro	0| 0 weken
1| 0 - 100000 Euro	1| 0 - 2 weken
2| 100000 - 250000 Euro	2| 2 - 4 weken
3| 250000 - 500000 Euro	3| 4 - 8 weken
4| 500000 - 1000000 Euro	4| 8 - 26 weken
5| > 1000000 Euro	5| > 26 weken
Gevolg veiligheid	**Gevolg omgeving**
0| Geen gevolgen voor veiligheid	0| Geen 0 - 5 min vertraging; 0 klachten; geen media
1| Geen letsel	1| Zeer klein 5 - 10 min vertraging; 1 - 2 klachten; geen media
2| Licht gewond, geen psychische klachten en minder dan 1 maand herstelperiode	2| Klein 10 - 15 min vertraging; 3 - 5 klachten; lokale media
3| Gewond of psychische schade en maximaal 1 maand herstelperiode	3| Middel 15 - 30 min vertraging; 6 - 10 klachten; provinciale media
4| Zwaar gewond met maandenlang herstel of revalidatie of psychisch herstel	4| Groot 30 - 60 min vertraging; 11 - 20 klachten; landelijke media
5| Dodelijk letsel of blijvend ernstige lichamelijke handicap of psychische schade	5| Zeer groot > 60 min vertraging; > 20 klachten; landelijke radio/TV

4.3 Cost Contingency Management

When an initial estimate for the cost contingency is made, and the project starts the execution phase, the cost contingency will have to be managed. As the project proceeds, the uncertainty and the amount of tasks should decrease, consequently, the bandwidth of the potentially necessary cost contingency will reduce. This is shown with the bandwidth marks in Figure 4.5. For a project team it is of high importance to be in control of the required amount of money in order to finish the project. Therefore, they revise the cost contingency estimation with up-to-date input.

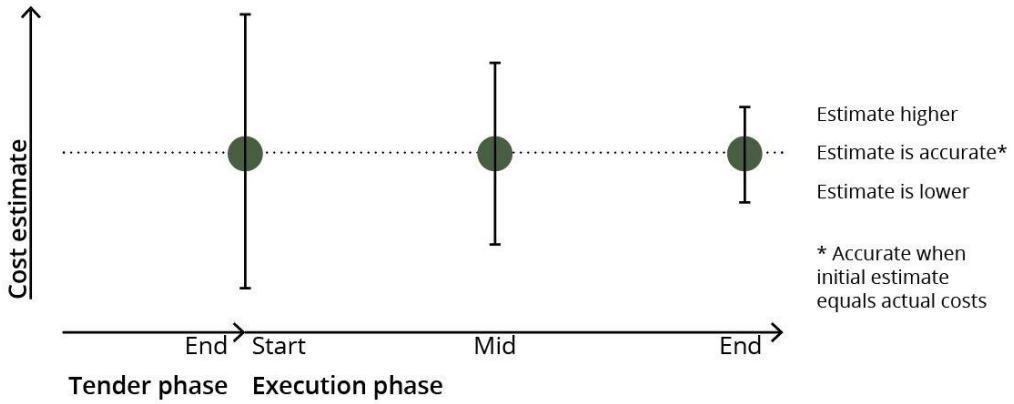


FIGURE 4.5 COST ESTIMATES DURING PROJECT EXECUTION PHASE

The risk and opportunity register is updated on a regular basis (preferably daily). New risks are added and quantified, while probability and consequence values of current risks and opportunities are updated (see Figure 4.6 on the left). Additionally, the financial and time impact is revised and calculated every quarter (3 months), based on this updated risk and opportunity register (see Figure 4.6 on the right). Whereas the first management process focusses on managing risk and opportunities (qualitatively), the latter aims at correctly estimating and updating the amount of cost contingency needed.

In literature, there are different methods suggested for managing cost contingency and estimating cost contingency. Concluding from the processes at Dura Vermeer, in practice there is no difference between the methods used for cost contingency estimation and management. An elaborate overview of the available cost contingency methods is discussed in section 2.3 ‘Cost Contingency Management’ and suggestions for improvement and implementation of the process are elaborated upon in the conclusion and recommendation chapters of this research.

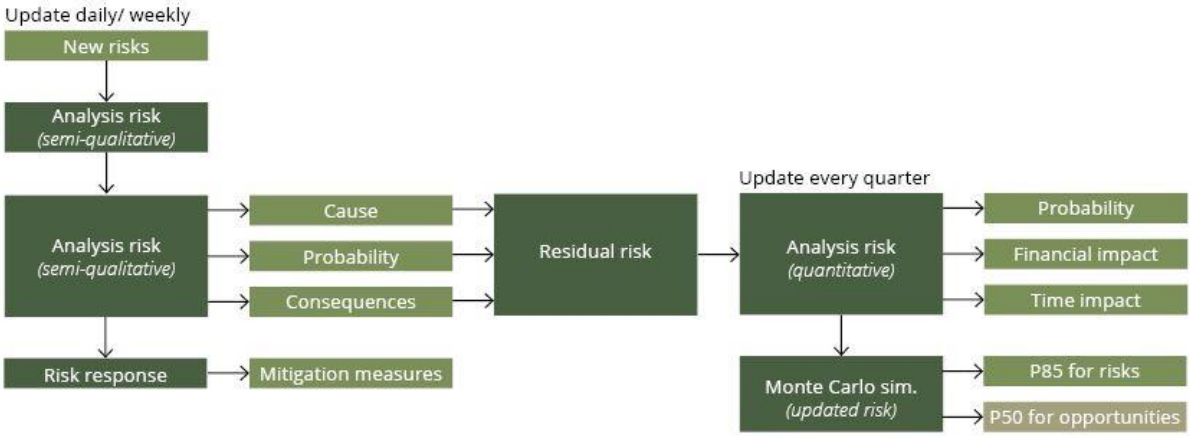


FIGURE 4.6 COST CONTINGENCY MANAGEMENT - UPDATING THE RISK AND OPPORTUNITY REGISTER

Cost contingency in the budget is part of a short list of cost elements that have the status 'critical'. Other elements in the short list are design costs, staff costs, labour costs, equipment and critical quantities (NL: ontwerpkosten, stafkosten, manuren, materieel (incl. ABK) en kritische hoeveelheden). These critical costs often cause cost overruns in the budget and therefore require close monitoring.

During the project the total budget remains the same, but cost elements within the budget can be changed and money can flow from one element to the other. In this way the cost contingency can increase or decrease during the execution of the project. For example, when an identified risk (one from the risk register) materializes, the costs resulting from that will be assigned to the specific cost element (in Dutch 'bewakingspost') of the project. When this cost element has a negative result, a part of the cost contingency can be used to cover for it. Such a reallocation of money must be approved by the project manager. Additionally, the risk is removed from the cost contingency (in Dutch 'vrijvallen van het risico in het K&R budget'). However, when a risk is not included in the risk register, the costs should also be paid from the specific cost element, and does not get compensated by the cost contingency. If this materialized risk has a major negative effect on the budget, the project manager can decide to allocate part of the cost contingency or unforeseen budget to compensate for the loss.

This way of managing and documenting the cost contingency is different from literature. Practice shows that risks are primarily booked on specific cost elements, instead of the cost contingency. Besides, the cost contingency and unforeseen both serve as a buffer to compensate for very negative results and the distinction between them is not very clear, as the project manager must approve of it. In conclusion, the initially unidentified risks (from the tender phase) should be covered in the spread of the base estimate, and in the unlikely event of a major negative result, it can be covered with the cost contingency or unforeseen.

During the project execution phase, the project controller (in charge of the budget), manages the budget by composing a 'EAC' (in Dutch 'PEW', meaning 'prognose einde werk') which translates to 'estimate at completion'. It considers at the given moment in time the left over budget, current costs and costs to be made until project completion. This is used as an indication to measure project performance at any point in the project.

4.4 Early Warning Signs

As mentioned in the previous section, the risk analysis process at Dura Vermeer is focussed on individual risks. The causes of the risks are registered in the risk and opportunity register in Relatics, but they are not evaluated or managed. The management of risks is focussed on the risks events themselves, rather than the causes or potential early warning signs.

Dura Vermeer applies key performance indicators (KPI) in their projects to monitor the performance during the execution phase. These vary from hard facts, such as the budget and planning, to soft factors, for example, communication with stakeholders, client satisfaction and progress permits. As discussed in literature, most of these performance indicators reflect the result of events that already happened: lagging indicators. However, the use of soft factors can help recognizing lead indicators and thus early warning signs. Currently, performance indicators with negative values are reasons to have a discussion with the client, which is a first step in acting upon early warning signs. But the performance indicators are not used in the context of early warning signs as they mainly reflect events from the past.

The absence of recognizing early warning signs suggests that the in literature identified surveillance filter is active. This means that early warning signs are not picked up, and therefore corresponding action cannot be taken.

5 Case Studies

For this research two cases studies were conducted to study the potential value of early warning signs in risk management and cost contingency management. First, the projects are briefly introduced. Then the availability of data and selection of risks to be analysed is explained. The initial idea was to analyse all materialized risks, but this was not possible in both projects due to the current risk documentation methods and software. Therefore, the progress reports were used as a starting point for detecting materialized and critical risks, because this report is used as a communication tool for 4-weekly updates about the status of the project to the client, including the top 20 risks. The short list with materialized or critical risks is analysed by means of desk study and in-dept interviews with the risk managers of Dura Vermeer who were responsible for risk management of the specific projects during project execution. With their input a cause-effect diagram is composed to visualise the network of these risks with their causes. Next, common causes and early warning signs are deducted from an analysis in which the risks are compared through time per common cause. Finally, the filters and barriers that block the ability to respond to early warning signs is evaluated briefly.

Two projects were selected for this analysis from a list of recently finished projects, so the data and end result of the project were available. The minor disadvantage of analysing finished projects is that the processes used might be outdated, as Dura Vermeer is gradually developing their processes over time. From the list, two projects were selected. They realised different objects: one built two bridges and a road and the other improved flood safety by adapting the landscape. The projects will be introduced in more detail in the following paragraph, followed by the analysis.

5.1 Project Description

5.1.1 N244-N246

Dura Vermeer executed maintenance for the client Provincie Noord-Holland on the roads N244 and N246 between Wormeerveer and Alkmaar, while improving the traffic flow and safety. They realised a new roundabout, crossing for bikers and 2 bridges. In order to build the new bridges, they constructed temporary bridges next to the old ones, to minimize hindrance. The execution started in December 2017 and finished in April 2020. The final project result was positive. The contact from Dura Vermeer is Silvester Pastoor, who was the process manager, who is also responsible for risk management.

5.1.2 Ooijen-Wanssum

Dura Vermeer is collaborating in this project for the client Provincie Limburg with Ploegam. The joint team (Dutch: ‘bouwcombinatie’) is called Mooder Maas. The goal of the project is to protect Limburg from flooding caused by high water levels in the Maas. This is realised by creating more space for the river water by lowering and widening the flood plains (Dutch: ‘uiterwaarden’). Additionally, non-traditional dikes are designed to match the landscape and a road with roundabouts are realised. The project area entails the area around Ooijen and Wanssum, which is surrounded by a natural landscape. In order to realise this project, a lot of soil had to be transported. The execution started in March 2017 and finished in December 2020. The contact for this analysis from Dura Vermeer is Ruben van der Zanden, who was a planner in the beginning of the project and took over risk management tasks in a later project phase.

5.2 Data Collection and Selection of Risks

5.2.1 N244-N246

The data collected from the progress reports is included in Appendix 1 'N244-N246: Data Extracted from Progress Reports'. It entails the risks with their RISMAN scores mentioned in all progress reports throughout the project execution phase. In this project the RISMAN score was determined by multiplying the probability by the sum of the consequences. The consequences reflect the six project goals: Money, Time, Image, Quality, Environment and Safety. As explained in chapter 4.2 'Cost Contingency Estimation' every aspect is assessed with a score between 0 and 5. In this project the initial and residual RISMAN scores are not used like described in the theoretical chapters. They use the initial RISMAN score to express the current score of the risk. Besides, there is not a clear pattern in reporting the initial or residual RISMAN scores in the progress reports. Due to these inconsistencies, the scores will be retrieved later via the software 'Relatics'.

Analysing every individual risk is time consuming and not a realistic goal for this research. Therefore, a selection is made to create a short list of critical risks. This is done with the use of a risk matrix as depicted in Figure 5.1 (left). The risks with high probability and major consequences are red in this diagram and are unacceptable. The yellow risks are acceptable with mitigation and the green ones have low probability and minor consequences and therefore acceptable. When translating the matrix to the values of this project, the probability is assessed on a scale from 0-5 and consequences 0-5 each, for each of the aforementioned six consequences (see Figure 5.1 right).

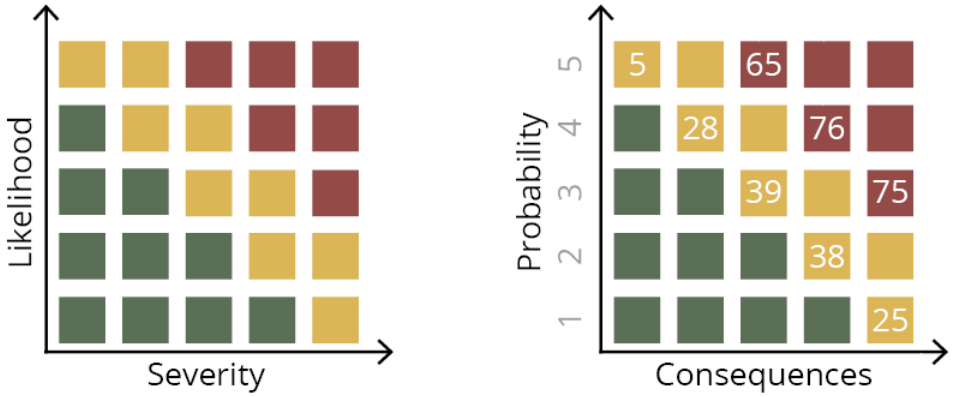


FIGURE 5.1 RISK MATRIX (LEFT: CONCEPT, RIGHT: SPECIFIC FOR N244-N246)

All risks with the label yellow or red are selected to form the short list. The list with the selection criteria is attached in Appendix 2 'N244-N246: Short list Risks Selected for Analysis'.

5.2.2 Ooijen-Wanssum

The data collected from the progress reports of Ooijen-Wanssum is included in Appendix 6 'Ooijen-Wanssum: Data Extracted from Progress Reports'. The RISMAN scores differ from project N244-N246, because this project assesses the risks on 5 consequences (instead of 6): Money, Time, Quality, Environment and Safety. The first 4 progress reports reflect on the period preceding the official start of execution phase. The contractor and client agreed there was a lot of preparation needed, so they started some work before the official date in the contract. Therefore, these reports are called 'preparation meetings' (Dutch: 'vooroverleg'). Both initial and residual RISMAN scores are reported per risk, but in the appendix only the residual risk is documented, because the initial RISMAN scores did not change over time and the residual RISMAN scores were used to reflect the current risk score.

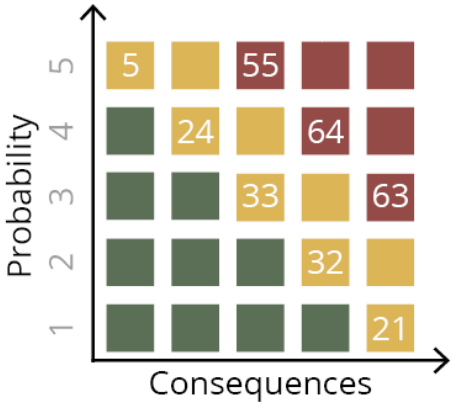


FIGURE 5.2 RISK MATRIX OOIJEN-WANSSUM

In the previous project it was not possible to select the materialized risks, but for this project there are some risks with status 'materialized' in the current state of the risk register (Relatics). The risks will be added to the short list to analyse. However, this does not include all materialized risks during the entire project execution phase, because the status of the risk might have been changed during project execution to 'mitigated', for example, after the risk has materialized and correctively mitigated. Therefore, all risks with status 'mitigated' are selected. Unfortunately, this list is too long to analyse all of them, because analysis of individual risks is time consuming. Therefore, the risk matrix is used to select the most critical mitigated risks. The risk matrix is adjusted to the values of this project in Figure 5.2. The mitigated risks in the yellow (acceptable with mitigation) and red (unacceptable) category are selected and the short list with selected risks for analysis is summarized in Appendix 7 'Ooijen-Wanssum: Shot List Risks Selected for Analysis'.

5.3 Analysis of Risks and Interviews

5.3.1 N244-N246

Due to irregularities in reporting the risks in the progress reports, the risk register was consulted for specific details on the risks. RISMAN input values from the entire project could be retrieved per risk, so the initial and residual RISMAN score could be reconstructed. This was done for every risk from the short list. The status of the risks were evaluated too.

During multiple interviews with the risk manager of this project the causes and consequences of the risks are discussed in detail. Moreover, the changes in RISMAN scores are discussed to try to explain the fluctuations. The notes of the interviews are attached in Appendix 11 'Interviews'. The information is used as input for the rest of the analysis. Statements made in the following section 5.4 'Cause-Effect and Early Warning Signs' are derived from the interviews, and can be referenced in the appendix containing the transcript of the interviews.

5.3.2 Ooijen-Wanssum

Since the RISMAN scores were documented consistently, there is no need to further analyse these scores. The risk register (in Relatics) was consulted for more detailed information about the risks, its mitigation measures, causes and consequences. The risk status could not be retrieved as easily as the other project, but could largely be reconstructed via the comments documented in the register. During multiple interviews with the risk manager of this project the causes and consequences of the selected risks are discussed in detail. The focus is on the materialized risks and how and why they could have happened. The interviews with the risk manager are included in Appendix 11 'Interviews'. The statements and results will be discussed in the following section.

5.4 Cause-Effect and Early Warning Signs

5.4.1 N244-N246

The goal of the interviews was to retrieve causes and issues leading to (materialization) of risks. The result is visualised in a causal relations diagram, which can be referenced in Appendix 3 'N244-N246: Diagram Risk Causes'. The diagram was discussed with and confirmed by the risk manager.

Risks illustrated in Figure 5.3 come down to an issue that arises in the tender phase of the project: tender documents provided by client contain mistakes. During the tender phase this might not have been recognized, because the estimates and plan are based on rough estimates. But quite soon after the start of the execution phase, the contractor continues to work on the design on a detailed level, for example the design of the bridge, and more information about the context and objects, for example due to inspections of the asphalt, becomes available, revealing errors in the documents from the client. Finding some of those errors should question the reliability of the other documents and the knowledge of the client concerning the objects of interest. Additionally, mistakes in tender documents that limit or complicate project execution lead to scope changes and other procedures to correct the errors. These complications will be discussed later in this chapter. Three out of these risks actually materialized during project execution (marked in yellow).

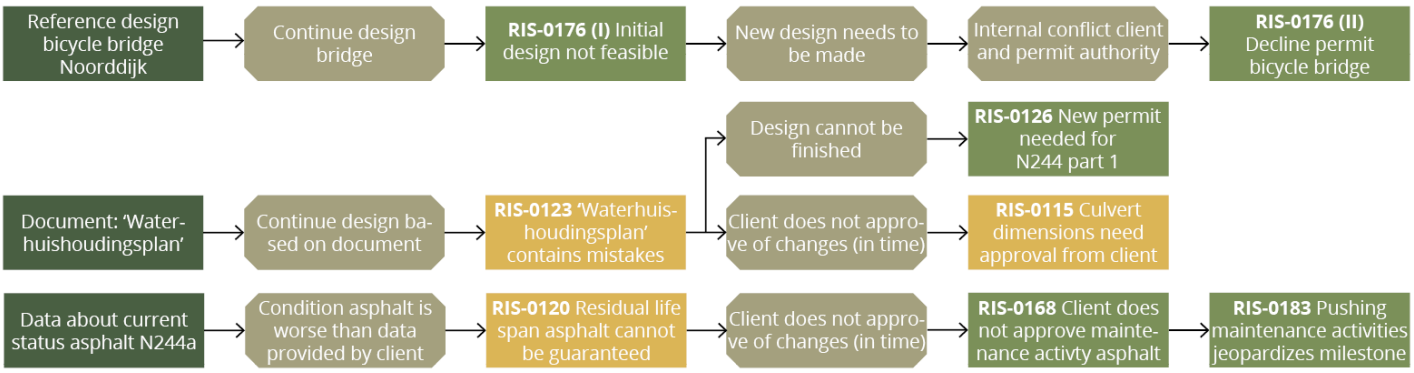


FIGURE 5.3 RISKS RELATING TO MISTAKES MADE IN TENDER DOCUMENTS

Figure 5.4 shows 4 risks and the causes leading up to these risks. Only one risk, RIS-0109, materialized. However, all of these risks share a similar theme, which are the formal requirements from the contract. These are requirements known in the tender phase already, but the risks might not have been identified during that phase. The first one RIS-0176 was identified when the more detailed design was made and the requirements from the client and their reference design did not match. Concluding from the figure, the other requirements were (suggested to be) changed, either by the contractor himself, or an external party, leading to the same problems as discussed in the previous paragraph, while needing official approval from the client or competent authorities to make sure the requirements are realistic and feasible again.

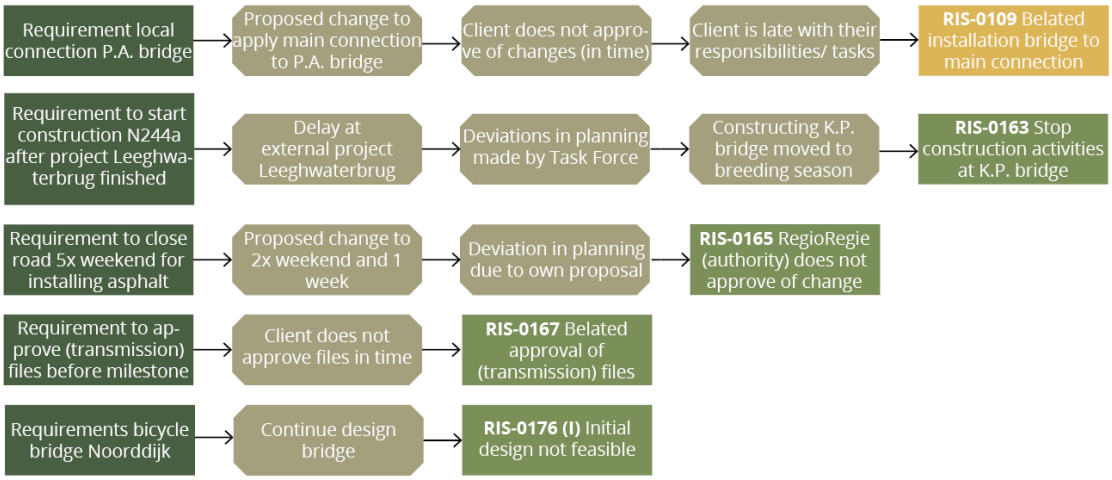


FIGURE 5.4 RISKS RELATING TO REQUIREMENTS THAT CANNOT BE MET

Another theme in this project that summarizes the underlying issue of some risks is the inexperience of the people in the client's project team. In this case the word inexperience is used to refer to describe the lack of familiarity with the organization's processes, due to hiring externals, and the limited knowledge about the project, as a result of the frequent rotation of people in the team. When they noticed this, they identified RIS-0119, which eventually materialized and preceded 4 other later identified risks (see Figure 5.5). Even though they were aware of the problem, and RIS-0119 materialized, still RIS-0174 materialized and lots of time and effort was spend on mitigating the other risks. With the current knowledge they could have taken more effective measures to mitigate the origin of these risks.

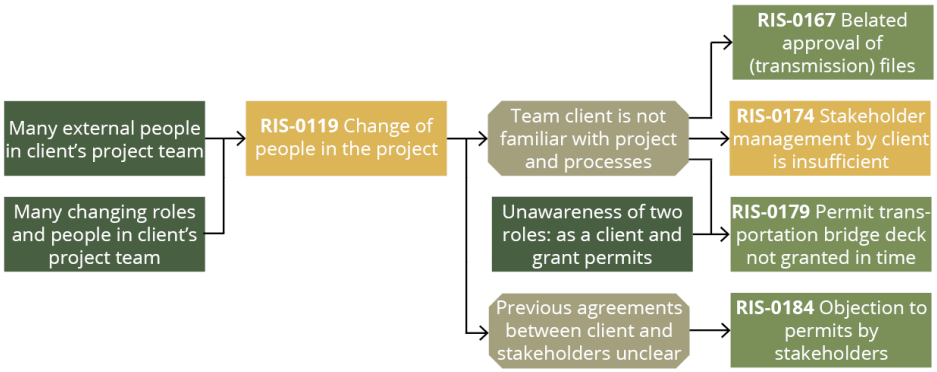


FIGURE 5.5 RISKS RELATING TO INEXPERIENCED CLIENT ORGANIZATION

In many of the previous diagrams another cause is mentioned, but not discussed yet. Many risks (almost) materialized resulting from poor and lengthy decision making process of the client, which is visualised in Figure 5.6. Other risks did not materialize, but were identified and mentioned in progress reports due to the lengthy decision making process that hinders project progress, to raise awareness and start the conversation with the client about this issue. In many cases the conversations with the client helped to prevent materialization of the risk, but it lead to large amount of undocumented failure costs, caused by these extra discussions and mitigation measures. In the end, most decisions were made JUST in time, which is unfavourable and stressful, but acceptable compared to decisions being made too late. The scope changes to be made by the client are derived either from their own mistakes in the contract, suggestions by the contractor for efficiency, or imposed by external authorities. Despite the diversity of the origin of the problems, the poor and lengthy decision making process of the client indicates an internal issue, which can effect many risks.

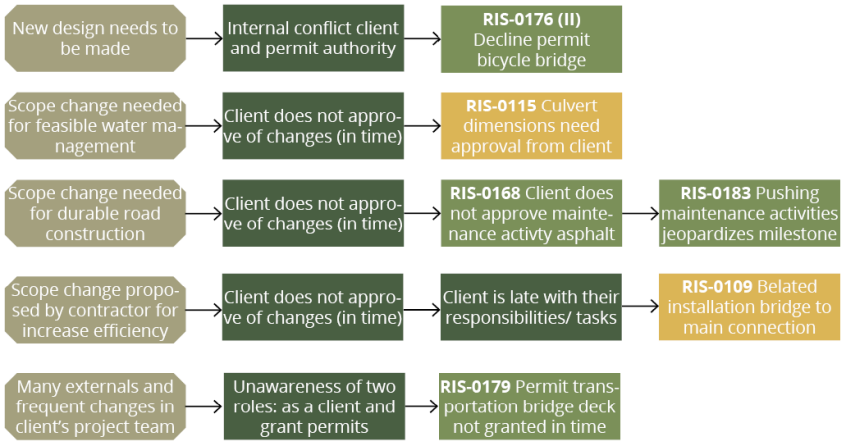


FIGURE 5.6 RISKS RELATING TO CLIENT'S POOR AND LENGTHY DECISION MAKING PROCESS

As projects are a large venture with many tasks, it is common to collaborate with other parties, like subcontractors and suppliers. RIS-0173 and RIS-0177 in Figure 5.7 are examples of issues arising from those collaborations. RIS-0163 is unique collaboration, as the Task Force manages the interface and dependency with other projects in the surrounding area. RIS-0165 shows the dependency on competent authority to approve the proposal. All these risks are caused by a struggle in the performance or approval of other parties, which lead to problems in this project, because they are dependent on them. Despite the risks originating from different collaborations, the main theme is that the consequences of these actions by third parties can have negative effects on the project, and concluding from Figure 5.7 at least one did materialize.

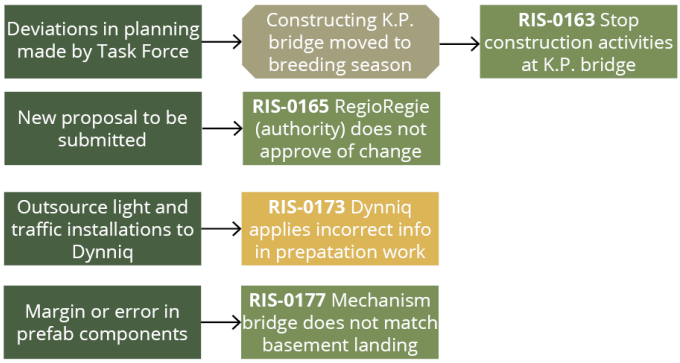


FIGURE 5.7 RISKS RELATING TO ISSUES CAUSED BY THIRD PARTIES

Undoubtedly, not all risks are related to the client, tender phase or external factors. The risks in Figure 5.8 follow from the contractor's own actions and tasks. Luckily, none of them materialized. However, materialization of one of these risks should trigger self-reflection and question the skills and experience of the person or team in charge. One occurrence might not be a problem, but if multiple mistakes are made, it might indicate an unskilled and inexperienced team.

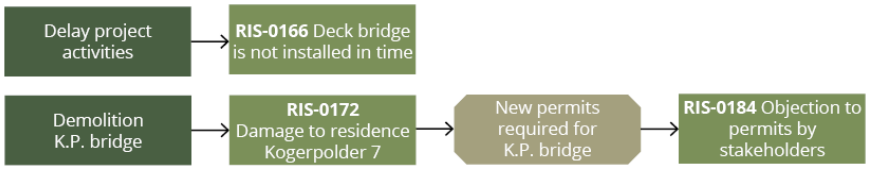


FIGURE 5.8 RISKS RELATING TO ISSUES RESULTING FROM OWN (CONSTRUCTION) MISTAKES

In this following part of the analysis the risks are combined in one figure per identified theme, so their data, RISMAN scores and risk status, is visualised over time. The data for Figure 5.9 until Figure 5.14 are included in Appendix 4 'N244-N246: Timeline Risk Score and Status for each Theme'. Every diagram will be discussed separately to analyse the risks for their increase in RISMAN scores and the chronological order of events to reveal early warning signs.

Three risks in Figure 5.9 materialized, which is illustrated with the red lines. RIS-0120 materialized in period 8 (see x-axis), while RIS-0115 and RIS-0123 followed in period 10. Even though there is only a period of 8 weeks between the two events, the materialization of RIS-0120 could have been an early warning sign for the materialization of the other two risks, as they are coming from the same origin, which is mistakes made by the client in the tender documents. Moreover, it looks as if the organization carefully managed the following risks with the same common cause, as the other risks keep their status identified and (preventively) mitigated. RIS-0115 and RIS-0120 were not identified before they materialized, which means these risks are 'unknown unknowns'.

Looking at the RISMAN scores, there are three risks that increased over time. The score of RIS-0123 increased simultaneous with changing status to materialized. This indicates that the effects of the materialized risks were higher than estimated. RIS-0120 changed even though it already materialized, meaning the effects of the materialization of the risks increased. The risk manager explained that after inspection of the asphalt, the quality was much lower than expected, leading to more maintenance activities. Next, RIS-0176 was marked as mitigated, but it kept increasing in RISMAN score. From the interviews it was concluded that agreements had been made with the client, and mitigation measures assured close collaboration, but the deadline approached and the permit was still not granted. The increase in probability caused the RISMAN score to increase as the deadline got closer.

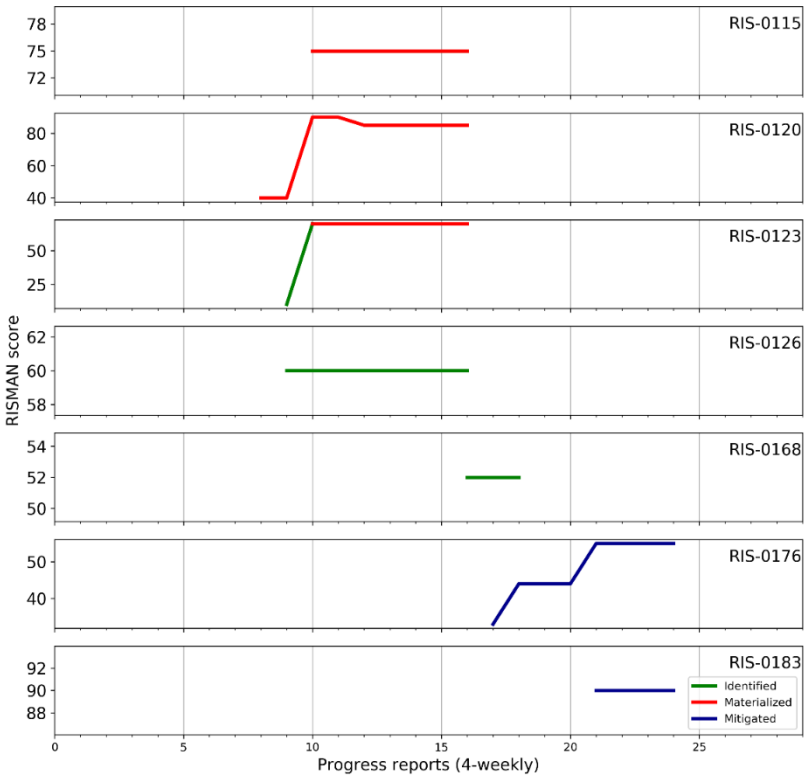


FIGURE 5.9 OVERVIEW OF RISKS (RISMAN SCORE AND STATUS) WITH THEME 'MISTAKES MADE IN TENDER DOCUMENTS '

In Figure 5.10 the risks related to 'Requirements that cannot be met' are depicted. RIS-0109 was the only risk that materialized, but also the first to be identified and no other events preceding the materialization. But before period 11 (materialization), the risk drastically increased in RISMAN score. This score was updated, because they discovered that the optical fibres were not installed yet. This came as a surprise, because the client had communicated that the preparation was already done. However, the client was not aware of the current status and was surprised with the situation too. The absence of the fibres can cause a delay in the planning. Eventually, the risk was correctively mitigated to lower the impact slightly. The last three risks show an increase in RISMAN score, even though they are identified as mitigated risks. For RIS-0165 the deadline to start construction approached, while they did not have approval yet of the competent authority to start construction works. At first sight, the description of RIS-0167 suggests a similar reason for the increase of the score, but the nature of this phenomenon is different. They were negotiating with the client to correct this mistake via a scope change, but despite the informal promise, the agreement was not set in stone yet. The increase in RISMAN was used to motivate the client to finish this task. RIS-0176 was discussed in previous paragraph already.

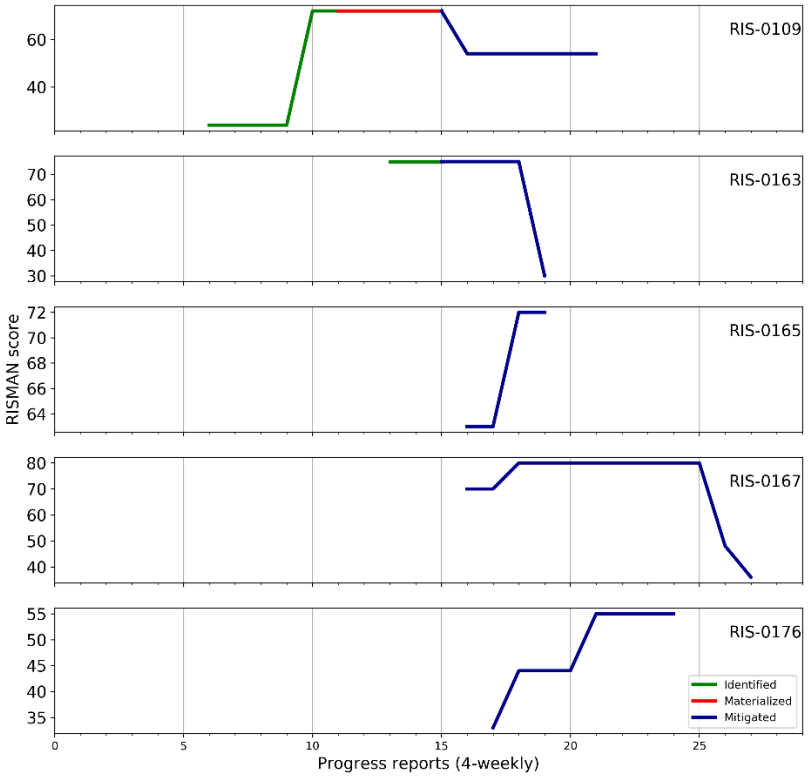


FIGURE 5.10 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'REQUIREMENTS THAT CANNOT BE MET'

RISMAN scores of risks caused by the inexperienced and unskilled client's organization are visualised in Figure 5.11. Only RIS-0119 materialized and from this figure no risks preceded this event. However, it was concluded from the interview that RIS-0174 actually materialized too. RIS-0119's score increased in period 10, after period 9 in which it materialized, due to two new people in the team of the client. They lost additional time and effort, more than initially expected, to involve and educate them about the project. Although the risk was mitigated in reporting period 15, the score increased again in period 18. The project team was indeed under the impression that the risk was mitigated, but the organization of the client had internal issues which kept their focus off this project, which can cause problems for the project as it approached milestones and deadlines. Moreover, RIS-0174 provides insight into the risk management approach. The risk manager explained they identified the risk during the 4 week period, and when making the progress report they expected that the conversation with the client would be an effective mitigation measure and the risk would be mitigated after the meeting. Therefore the status or this risk was directly reported as mitigated. However, in the next meeting, the client had not taken any action to improve the situation, so the RISMAN score was increased.

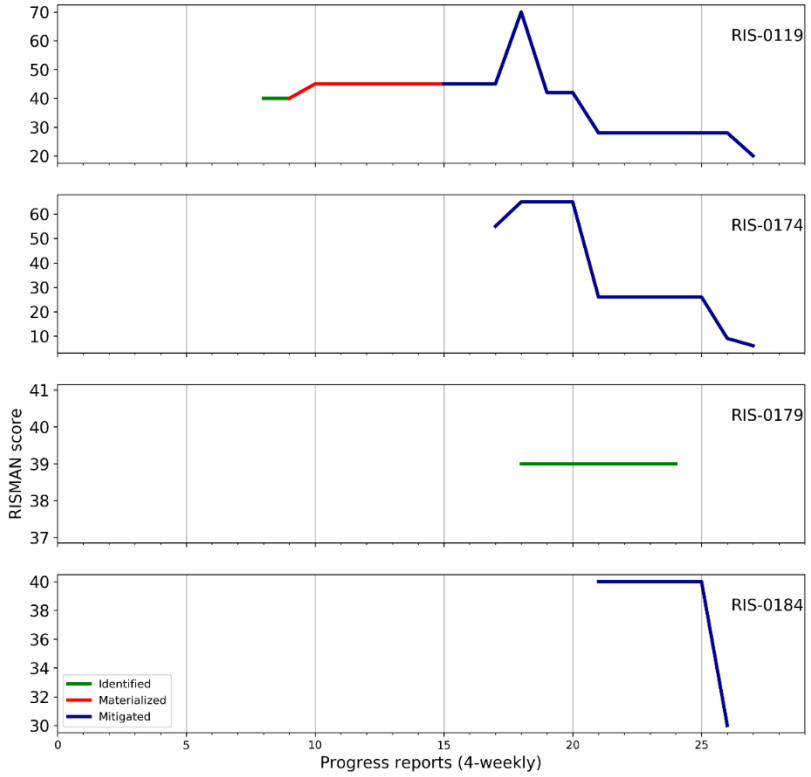


FIGURE 5.11 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME ' INEXPERIENCED CLIENT ORGANIZATION '

Many risks are depicted in Figure 5.12, because they all state problems and effects resulting from poor decision making of the client. In most cases the risk materialized if the decision of the client was made too late and the project suffered delay or financial loss. In other cases the risk did not materialize but the increase of the RISMAN score suggests an approaching deadline and the urgency of the decision to be made. The two events preceding the materialization of RIS-0109 are the increase of RIS-0109 itself, and the materialization of RIS-0115. Both could serve as a warning that the decision making of the client is very lengthy at the moment, and problems might arise elsewhere in the project because of it. The specific reasons for the RISMAN increase of RIS-0109 and RIS-0176 were already discussed earlier.

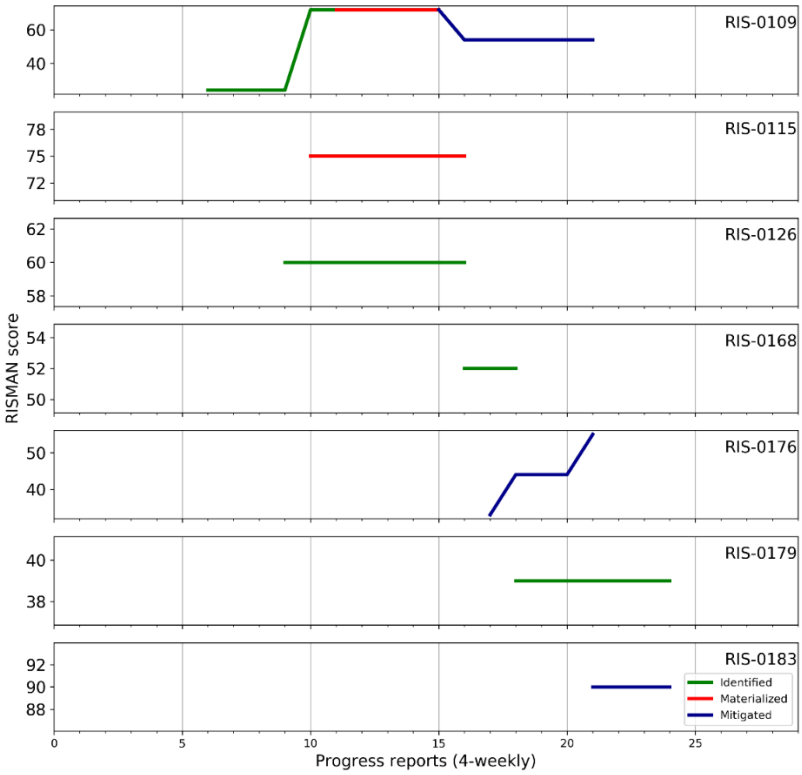


FIGURE 5.12 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'CLIENT'S POOR AND LENGTHY DECISION MAKING PROCESS'

Figure 5.13 shows three mitigated risks. RIS-0165 includes the risk of the newly handed in proposal that takes too long to get accepted by the competent authority. Without authorization, they were not allowed to start working, but the starting date for construction activities approached. RIS-0173 shows a RISMAN score that declines in period 21 and inclines again a few weeks after (in period 24). In this case the contractor thought that the subcontractor was able to perform his tasks properly, hence the mitigated status of the risk and the decline of the score. However, small problems started to arise with their schedule and the probability of the risk materializing increased. The risk manager mentioned that this risk actually materialized, in period 24, when the score increased.

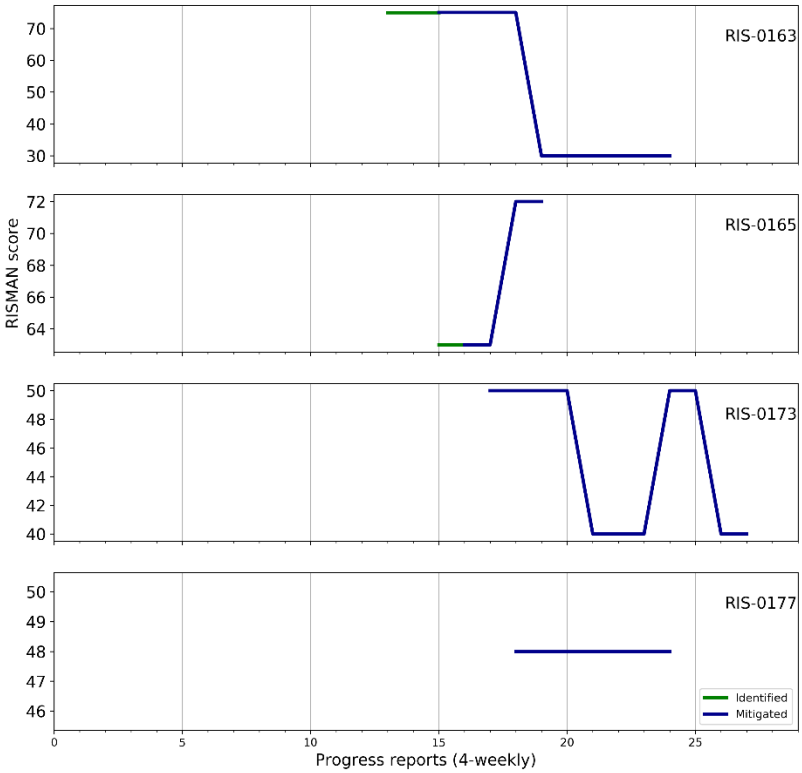


FIGURE 5.13 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME ' ISSUES CAUSED BY THIRD PARTIES '

The last diagram of this section, Figure 5.14, contains risks related to issues resulting from own (construction) mistakes. None of the risks materialized, but some RISMAN scores increased, suggesting some changes in the circumstances or perception of the risk. RIS-0166, increased due to approaching deadlines. The construction activities took longer than expected, the milestone to finish the construction approached so the probability of the risk materializing increased.

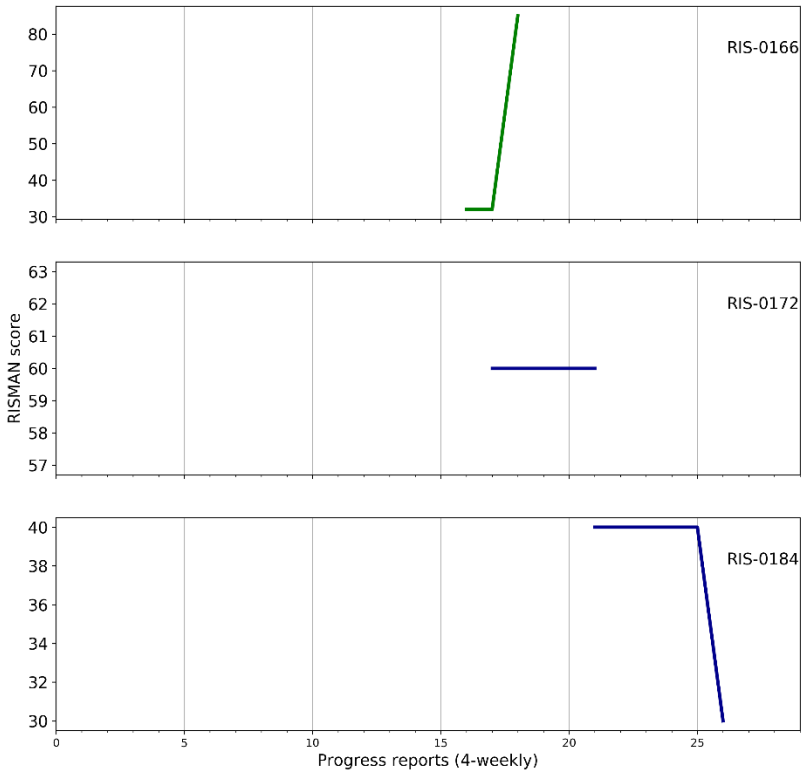
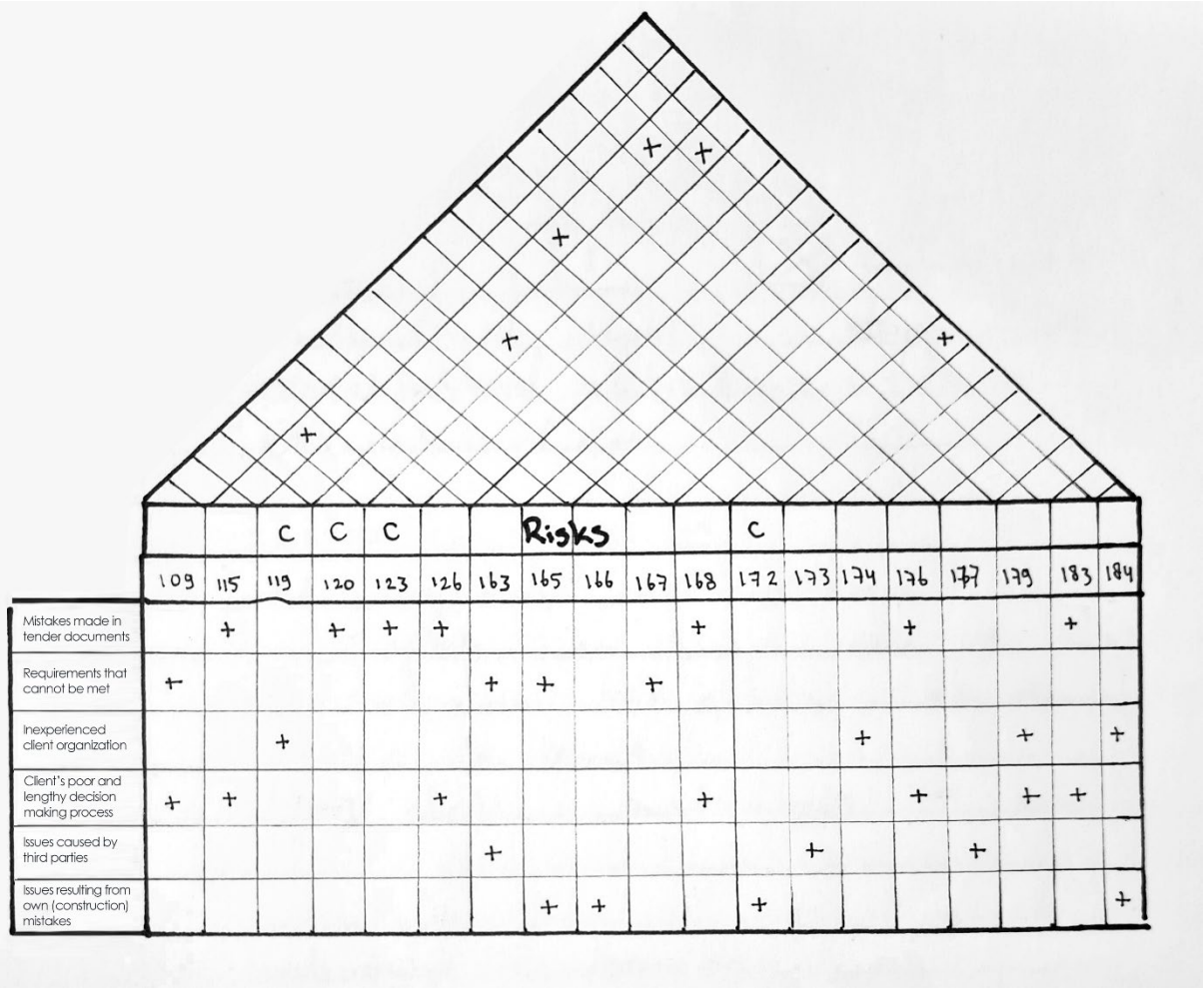


FIGURE 5.14 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME ' ISSUES RESULTING FROM OWN (CONSTRUCTION) MISTAKES '

To conclude, in this case study various early warning signs have been detected in hindsight by analysing risks, their status and their RISMAN scores, as well as their causes. First of all, themes were identified based on content and cause analysis. Most of the themes describe a cause or issue that precedes the (potential) materialization of those risks associated with it and reflect the main issues in this project. The themes are 'Mistakes made in tender documents', 'Requirements that cannot be met', 'Inexperienced client organization', 'Client's poor and lengthy decision making process', 'Issues caused by third parties', 'Issues resulting from own (construction) mistakes'. These common themes and causal relations between risks are simplified and translated to an overview represented in Figure 5.15. The themes in the left column are related to risks when there is a + sign in the cell that follows from the combination of row and column. For example, 'Mistakes made in tender documents' relates to risk 115, 120, 123, 126, 168, 176 and 183. On top of the risks columns a roof is drawn to show the relation between the risks. Risks containing a 'C' are causes for risks that are marked with a + sign at the intersecting cell. For example, risk 172 has a causal relationship with risk 184, in which the former is the cause and the latter the effect.

Most of these causes reflect the dependency on the client (varying from their preparation in the tender, till their organization's culture). All issues, a until f, happen prior to the risks, which suggests that these issues function as early warning signs, if they are detected by the project team. In this case the project team was not specifically aware of these issues before the risks arose.



Note: The 'c' at the top of some risks indicate they are positioned prior to another risk in the chain of events.

FIGURE 5.15 THEMES AND RISKS RELATION DIAGRAM N244-N246

Second, timelines of the RISMAN scores per risk reveal chronological order of events and shows what type of phenomena happened before a risk materialized. Unfortunately, not many risks materialized in this selection, but from the ones that did two things usually happened: materialization of another risk with the same cause, or an increase of the risk itself or another risk with the same theme or cause. Third, the RISMAN timeline is expected to be constant or decline over time when a risk is mitigated. However, this project showed some anomalies in the RISMAN score compared to this expectation. The anomalies had several causes and are justified with an explanation from the risk manager. In Table 5-1 the type of justifications are summarized and categorised based on the status of the risk at that time.

TABLE 5-1 N244-N246 SUMMARY OF ANOMALIES PER RISK STATUS AND JUSTIFICATION

Status risk when score changed	Risks	Urgency/ deadline	Strategic communication	Discovery/ changed circumstances	Optimistic estimation
Identified	RIS-0109			+	
Identified	RIS-0119 (I)				+
Materialized	RIS-0119 (II)	+			
Materialized	RIS-0120			+	
Materialized	RIS-0123				+
Mitigated	RIS-0165	+			
Identified	RIS-0166	+			
Mitigated	RIS-0167		+		
Identified	RIS-0173	+			
Mitigated	RIS-0174		+		
Mitigated	RIS-0176 (I)	+			
Mitigated	RIS-0176 (II)	+			
	Total	**6**	**2**	**2**	**2**

Remark about materialization of risks

All materialized risks happen in period 8 till 11. Afterwards there were no risks found that materialised. This could indicate various things, for example that the other risks were managed well (mitigation status is seen often), or the amount of work declined over time and most risks are linked to activities that were scheduled in the first half of the project.

As discussed before, it was not possible to filter the risk register on materialized risks or find an alternative way to gather the materialized risks. Therefore the conclusions concerning early warning signs are not as strong and evidential as intended.

Remark about the status mitigated after period 15-16

Many risks from this analysis received the 'mitigated' status around progress report 15 and 16. This event aligns with the change in risk manager and the change in reporting risks in the same period. The question remains whether those risks are actually mitigated, or whether the personal interpretation of the risk managers differ, or whether the status was used to optimistically present the project in progress reports.

In these figures there is no distinction between preventively and correctively mitigated risks. Additionally, no information could be retrieved on the costs associated with mitigating the risks, e.g. formal or informal mitigation measures. Therefore, no conclusions can be drawn about whether it was beneficial to invest in mitigating the risk compared to the costs of a materialized risk.

Remark about RISMAN scores

In the figures the initial RISMAN scores are used. This choice is made, because most risks did not have a residual RISMAN score at all, or had 1 constant value over time. Concluding from this, the initial RISMAN score was used as the 'current' RISMAN score and therefore representing the current situation the best.

5.4.2 Ooijen-Wanssum

The short list with selected risks are analysed to detect their causes and reasons for materialization. From this analysis a few similar issues and causes were detected, which will provide the structure of the upcoming paragraphs. The risks will be discussed per common theme.

A fair amount of risks, visualised in Figure 5.16, found their origin in details from the requirements stated by the client in the tender phase. Except for RI-022, these risks result from decisions by the client, which a bit unlikely, or even risky for the contractor to execute the project, such as the limited construction period (RI-032) or limited availability of the project site (RIS-0178, RIS-0193, RIS-0324 and RIS-0331). The contractor is aware of the (additional) risk, and is able to take this into account when estimating cost contingency for the project. On the other hand, RI-022 derives from a requirement too, but according to the contractor, the comment is ambiguous and they intentionally take a risky decision. Unfortunately, RI-022 materialized, like 4 others in the diagram coloured in yellow, and the project suffered some losses, despite the awareness of the risk and cause. A large amount of those risks, or the materialization of one of those risks could serve as an early warning sign for the other risks.

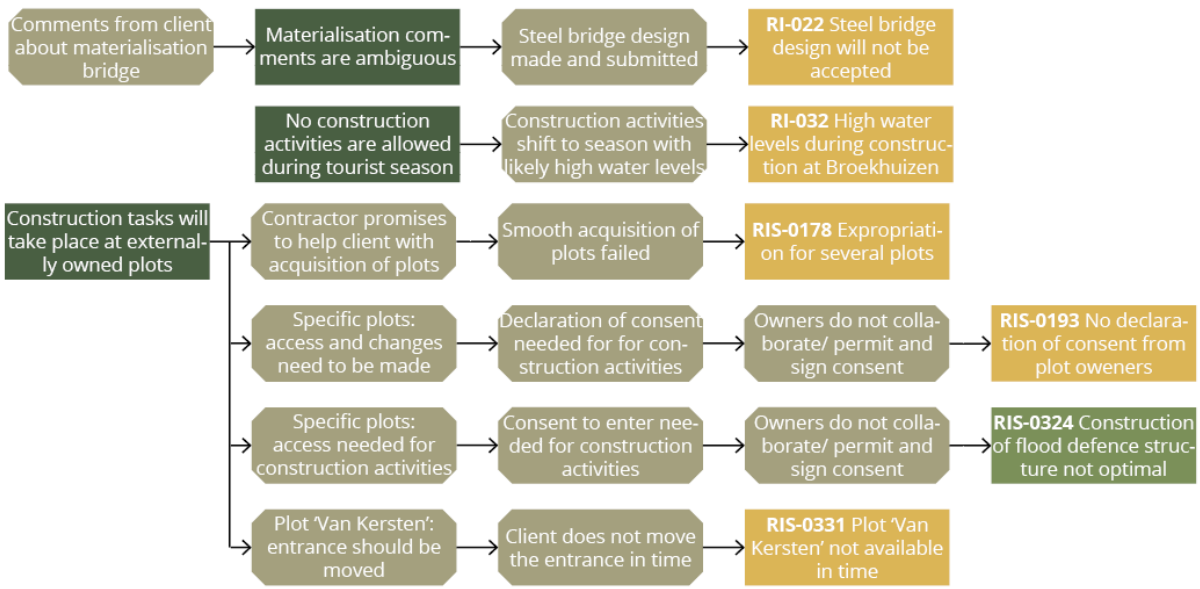


FIGURE 5.16 RISKS RELATING TO RISKY OR UNREALISTIC REQUIREMENTS IN CONTRACT IN TENDER PHASE

As is commonly known, the information and data available in the tender phase is limited. Likewise, this project encountered some risks that materialized, RI-021, RIS-0313 and RIS-0192, due to lack or incorrect information known in the tender phase, visualised in Figure 5.17. This issue locates itself in the tender phase and little can be done to check the data or generate more data. But, when the tender is won, the contractor can quickly start inspecting and checking this data. Especially, when the first few additional information suggests errors, the other data can be questioned on their reliability. This could be an early warning sign.

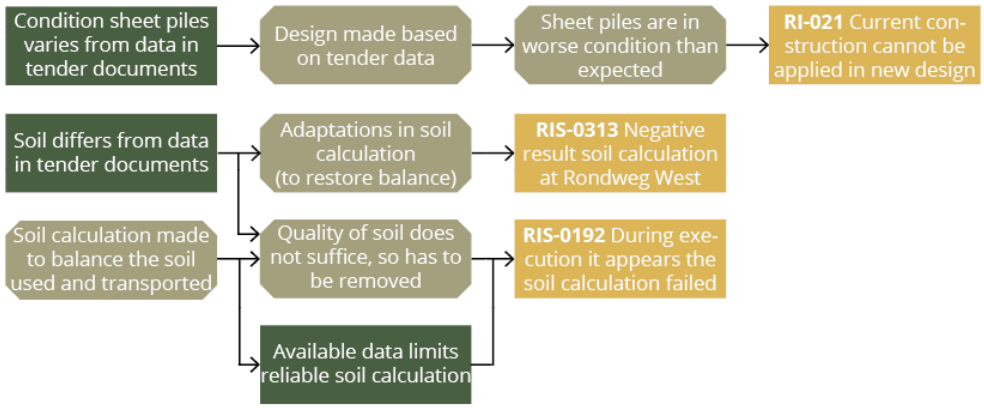


FIGURE 5.17 RISKS RELATING TO LACK OF DATA IN TENDER PHASE

During the tender phase the contractor writes an appealing document, in which several promises are made, to convince the client to select him to execute the project. In this project he contractor designed a non-traditional dike, promised to help with the acquisition of externally owned plots and made a soil calculation to limit soil transportation (see Figure 5.18). These promises coexist with additional risks, which are known by the contractor from the beginning of the project, since they consciously accepted to take the risk. With this knowledge in the tender phase, the contractor could have included more cost contingency to compensate for these risks. And when one of them materializes, the contractor should analyse whether the other promises they made are still realistic or whether they were too optimistic too.

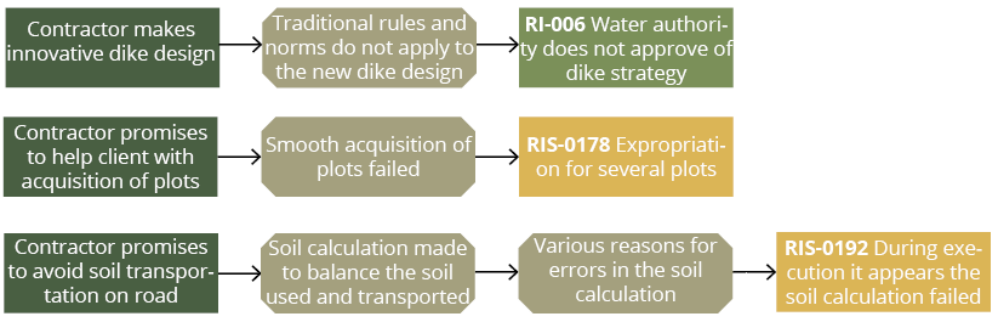


FIGURE 5.18 RISKS RELATING TO NOT BEING ABLE TO KEEP PROMISES FROM TENDER

In Figure 5.19 risks are gathered that are consequences of actions by the contractor himself due to, for example, delay in construction tasks, optimistic estimations or other choices made during the project. Materialization of one risks might be an accident, but having four of those risks effecting the project triggers to ask questions about the skills and knowledge of the project team: mistakes are human, but how many risks with this cause are acceptable, or could it have been prevented?

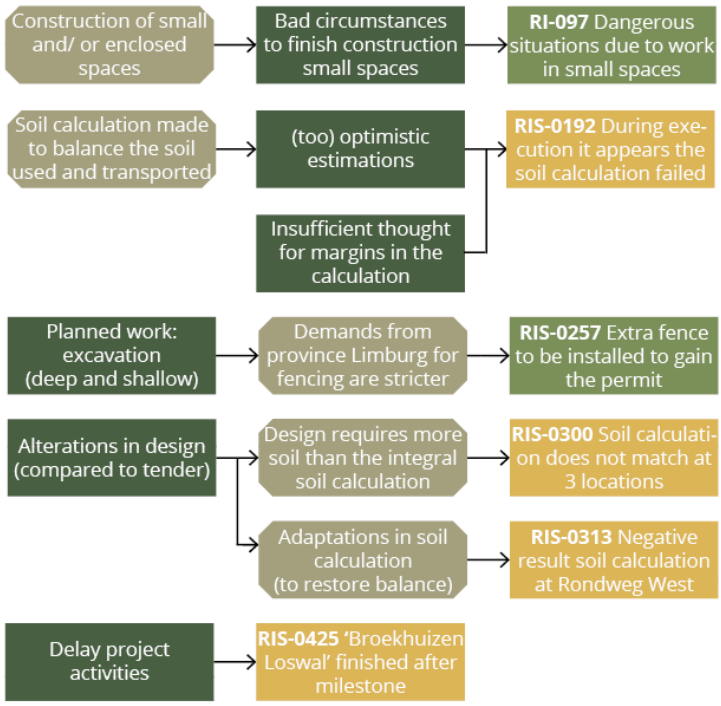


FIGURE 5.19 RISKS RELATING TO FAILURE OR MISTAKES MADE BY CONTRACTOR (HIMSELF) DURING EXECUTION

Stakeholders play an important role in realisation of a project. In this project some stakeholders had specific requirements, which were discussed with the client beforehand. Others had to be negotiated with to get consent for either accessing their plot or altering part of their land. It was a given at the start of the project that collaboration from these stakeholders was needed, however, the relationship still had to be built. When RI-032, and later RIS-0193, materialized (indicated with the yellow blocks in Figure 5.20), it revealed some information about the difficulty of getting consent from stakeholders, and thus about the other risks relating to this. Furthermore, if many risks relate to the permission and requirements from the stakeholders to access their plots, it might be an early warning sign that stakeholder management should be executed carefully, as many risks depend on it.

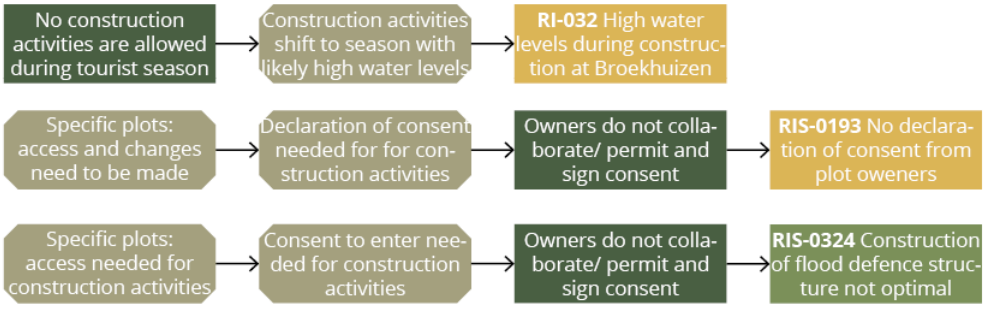


FIGURE 5.20 RISKS RELATING TO UNCLEAR, UNKNOWN OR CHANGING PREFERENCES/ REQUIREMENTS FROM STAKEHOLDERS

Three risks were identified in the analysis to have causes relating to getting the right permits from competent authorities. In Figure 5.21 these are visualised. Even though the specific authorities and the permits vary per risk, the theme remains the same and it can be an early warning sign for this project. When multiple risks materialize, it can be argued whether the project team is aware of these procedures, or whether there are so many scope changes that new permits have to be requested, or another issue that might influence other aspects of this project and thus other risks too. Looking at Figure 5.21 only RIS-0422 materialized, and it will be discussed in more detail in Figure 5.23, as this risk has two causes.

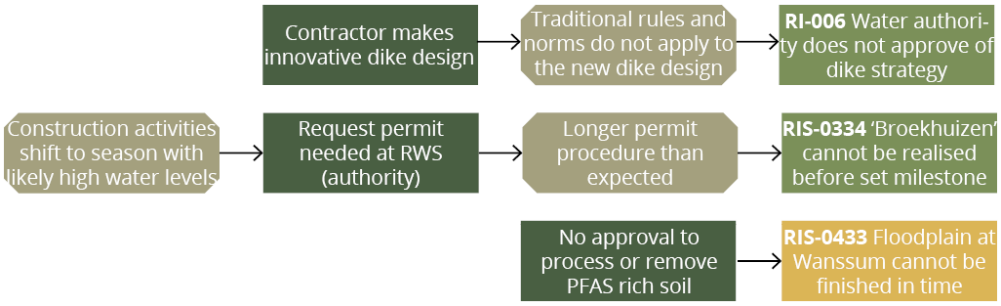


FIGURE 5.21 RISKS RELATING TO ISSUES WITH PERMITS DUE TO COMPETENT AUTHORITIES

The risks in Figure 5.22 is similar to the risks in Figure 5.21, because they develop from issues with external parties, of which every one refers to a different individual party. However, these dependencies and risks are usually known in the early phases of the project, and therefore reveal information about the criticality of these parties for the success of the project.

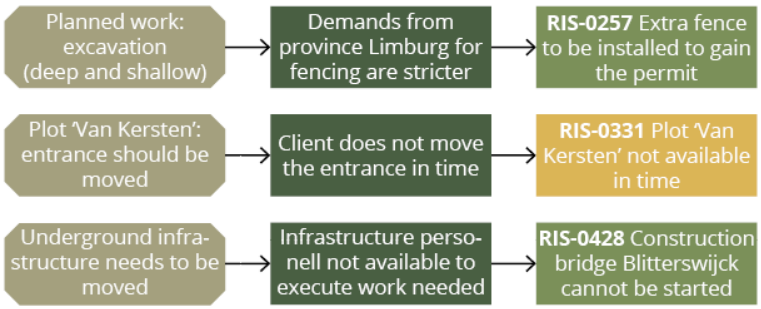


FIGURE 5.22 RISKS RELATING TO ISSUES WITH THIRD PARTIES

The last risk was already shortly discussed before, but the origin of the cause lies in a change of national regulations, illustrated in Figure 5.23. The rules for concentration of percentages allowed in the soil changed, which resulted in new requests for permits and a large amount of soil that could not be processed. This type of change in circumstances comes from an external source and is considered beyond the power of the contractor. In literature it is also known as a 'black swan', which are risks with a huge impact, but very low probability. As the contract had a good relationship with the client, they tackled this problem together. Additionally, as there is only one risk evolving from this theme, it will be neglected for the continuation of this research.

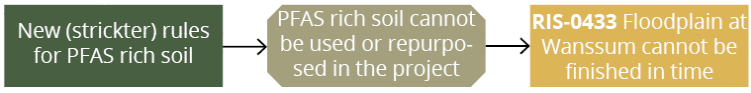


FIGURE 5.23 RISK RELATING TO MAJOR CHANGES DUE TO EXTERNAL FACTORS

In the following part of the analysis the risks are combined in one figure per common cause, so their data, RISMAN scores and risk status, is visualised over time. The data for Figure 5.24 until Figure 5.30 are included in Appendix 9 'Ooijen-Wanssum: Timeline Risk Status for each Theme'. Every diagram will be discussed separately to analyse the risks and reveal potential early warning signs.

In Figure 5.24 the common cause 'Risky or unrealistic requirements in contract in tender phase' is the subject of interest. The first 4 risks were identified early on in the execution phase and 5 out of 6 risks from the total diagram materialized. In chronological order: first RI-022 and RI-032 were identified during the tender phase (before period 1). Then RIS-0178 was identified and simultaneously RI-022 increased in value. Next RI-022 materialized, while RIS-0178 spiked down (potentially an admin error, based on the data and interviews) and an unidentified risk RIS-0193 materialized. While RIS-0193 decreased over time in the next period, 2 new risk, RIS-0324 and RIS-0331, was identified and later RIS-0178 and RI-032 materialized. Eventually RIS-0331 materialized too. This sequential order of events suggests that early warning signs could have been present, but missed and therefore risks later in the chain of events materialized. The requirements from the tender phase are known in the early stages of the project, and when RI-022 and RIS-0193 materialize at the start too, the contractor is warned that the requirements in the contract might be too risky, and should be evaluated again.

Moreover, there are some increases of the RISMAN score in this diagram, which suggests an escalation of the risk (impact or probability). The increase in score of RI-022 was explained by the risk manager as an error in estimation, as the contractor expected to be able to convince the client to agree with their steel bridge design. However, after some conversations it became clear that the client desperately wanted a concrete bridge, which had a larger impact on the project than estimated in the tender phase. The increase in RISMAN score of RI-032 derived from developing the design and organizing working sessions with stakeholders, in which the contractor found out that the scope of the project was larger than estimated in the tender, which affected the project schedule. Finally, RIS-0331 increased in score twice, while having the identified status and growing higher than the initial RISMAN score. The first instances derives from additional information being brought to light when conversations with the specific stakeholder started. The contractor realised the consequences would be much larger when the risk were to materialize. The second increase in RISMAN score, in progress report 36, arose from the approaching deadline to finish the task, while the problem with the stakeholder has not been solved yet.

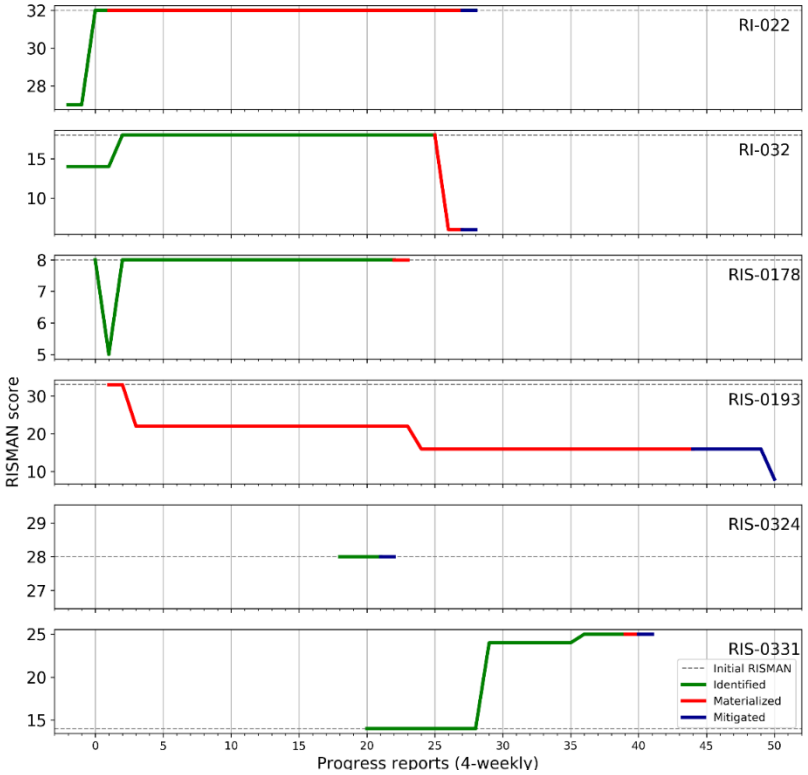


FIGURE 5.24 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'RISKY OR UNREALISTIC REQUIREMENTS IN CONTRACT IN TENDER PHASE'

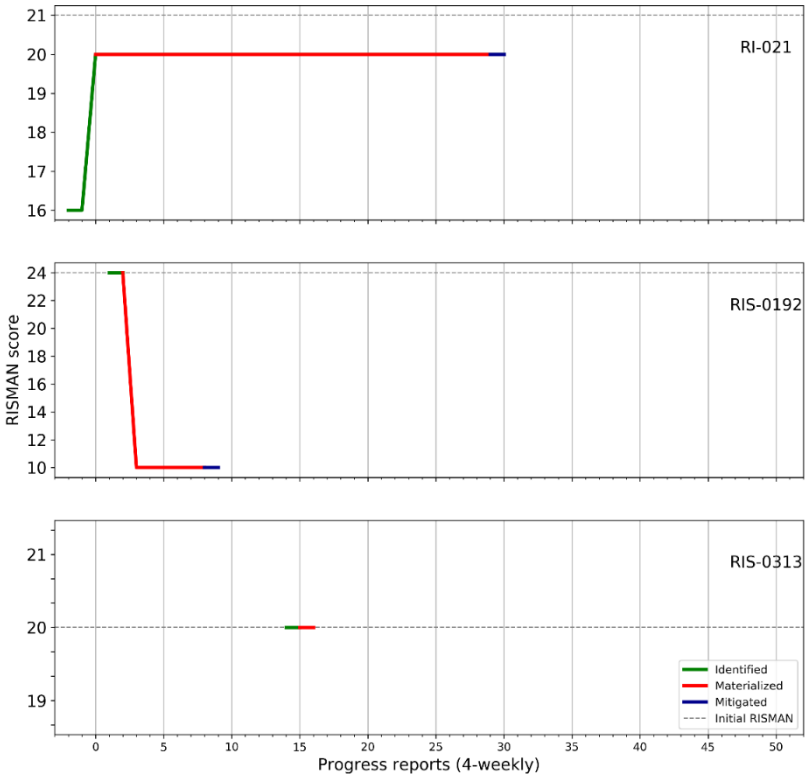


FIGURE 5.25 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME ' LACK OF DATA IN TENDER PHASE'

All three risks with the theme ‘Lack of data in tender phase’ materialized. In Figure 5.25 the risks are illustrated. It can be concluded that first RI-022 was identified and materialized, so no early warning sign is found for this specific risk. However, the materialization of RI-022 itself functions as an early warning for the materialisation of the other two risks. Furthermore, the consequence of RI-022 was higher (RISMAN 20) than expected (RISMAN 16) and the effect of RIS-0192 was lower (RISMAN 24) than expected (RISMAN 10).

Figure 5.26 shows risks resulting from ‘not being able to keep promises form tender’. Likewise, the risks are identified in the tender phase or very first period of the execution phase. This shows that the contractor was aware that some of their promises included risks. RIS-0192 materialized quite quickly, but the impact was lower than expected (RISMAN 10). Thereafter, RI-006 was successfully preventively mitigated causing the RISMAN score to decline. But even with one preventively and one correctively mitigated risk, the third risk, RIS-0178, materialized later. As discussed earlier, the spike going down and up in the RISMAN score of RIS-0178 is probably due to an administrative error. Concluding from Figure 5.26, these materialized risks have low consequences (RISMAN 8 and 10), but there was a clear chronological order of events, and the materialization of RIS-0192 could have been an early warning for RIS-0178.

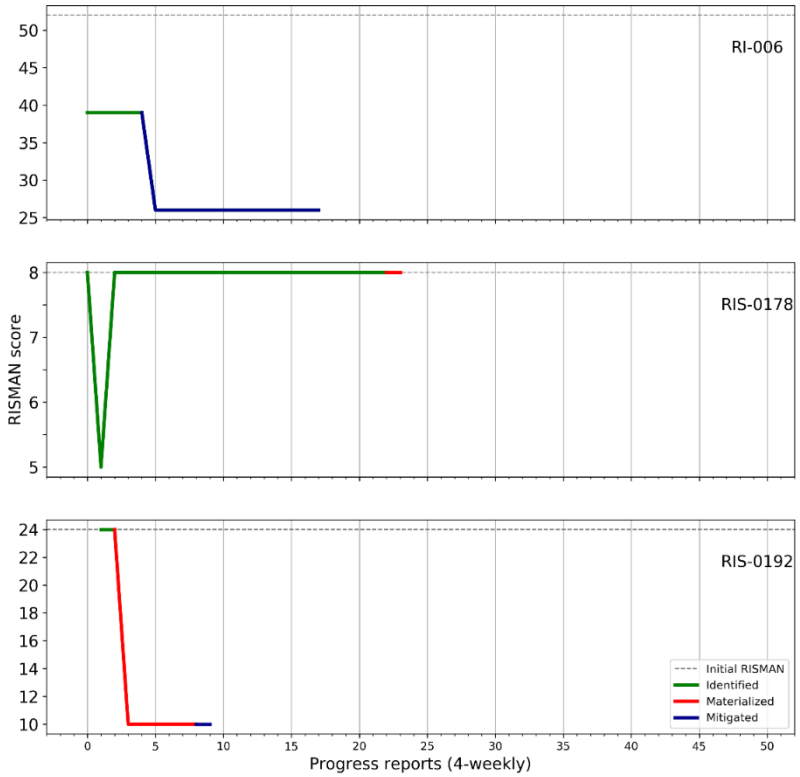


FIGURE 5.26 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME ‘NOT BEING ABLE TO KEEP PROMISES FROM TENDER’

From the short list of risks, seven resulted directly from the actions and execution work from the contractor himself. These are summarized in Figure 5.27. The risks concern different tasks and are spread across the project timeline. Four out of seven risks materialized. However, the common factor is the project team itself. Mistakes are human, but in this case four mistakes turned into materialisation of risks with negative consequences for the project. An extensive evaluation or reflection after materialization of RIS-0192 might have prevented the materialisation of any more risks with this cause.

RIS-0425 shows all three status of the risk with a RISMAN score of 25. This is higher than the initial RISMAN, which is 16. The risk manager argued that this graph follows from the way of reporting risks in the progress reports. It is likely that this risk was not documented before period 40 in the progress reports, because the RISMAN score was too low. But when circumstances changed, the estimation was adjusted and the risk become more urgent and ended up in the top 20, and therefore presents itself in the progress reports and the graph of Figure 5.27.

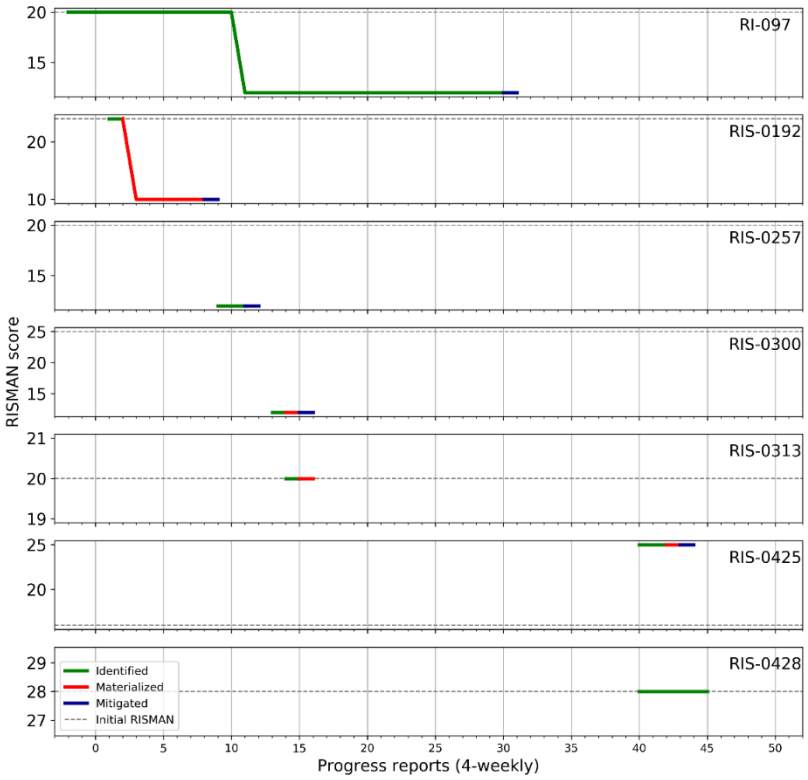


FIGURE 5.27 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'FAILURE OR MISTAKES MADE BY CONTRACTOR (HIMSELF) DURING EXECUTION'

In this project there were many stakeholders involved, hence some risks find their source in this common cause. In Figure 5.28 these three risks are visualised. RI-032 increased in RISMAN score, due to newly acquired information, at the same time as RIS-0192 materialized. While the impact of RIS-0193 decreased over time and eventually was mitigated, RI-032 materialized before it was mitigated, but with lower consequences than expected.

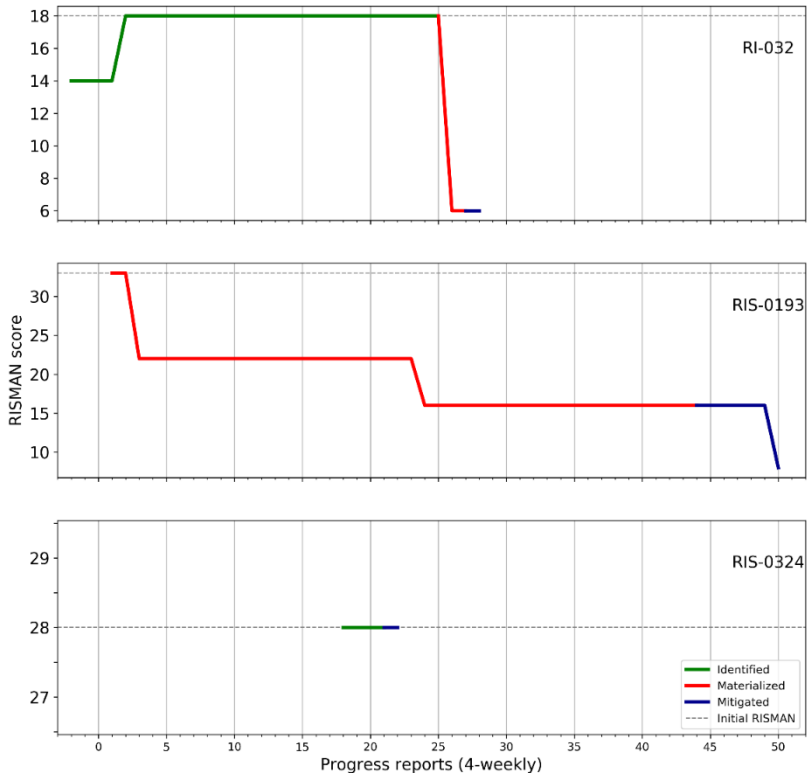


FIGURE 5.28 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'UNCLEAR, UNKNOWN OR CHANGING PREFERENCES/ REQUIREMENTS FROM STAKEHOLDERS'

In Figure 5.29 risks relating to 'issues with permits due to competent authorities' are depicted. Even though the authorities of interest differ per risk, there is still a chronological order to be detected in identification and managing of risks. When RI-006 is preventively mitigated, RIS-0178 is detected and mitigated, after which RIS-0192 is identified and materialized. The last of those three risks materialized, but there were two similar and preceding risks preventively mitigated. Fortunately, the consequences were minimal (RISMAN 22 to 16). But as discussed before, this last risk was a unique one, resulting from a change in regulations.

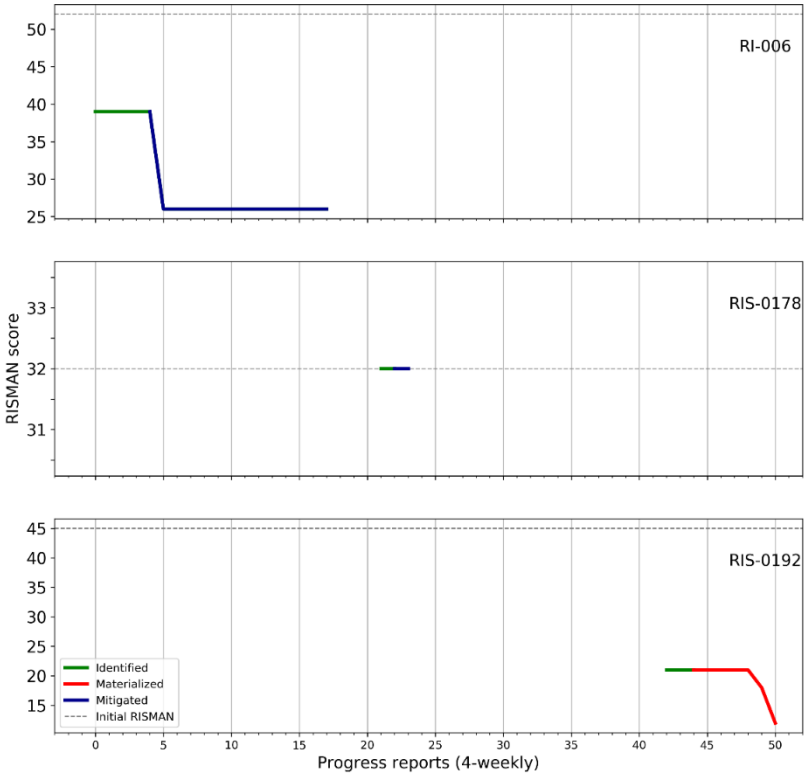


FIGURE 5.29 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'ISSUES WITH PERMITS DUE TO COMPETENT AUTHORITIES'

The final risks in this analysis that share a common theme are visualised in Figure 5.30. From these risks RIS-0331 is the most critical, as the RISMAN score increases over time and eventually the risk materializes. RIS-257 precedes this incident, but specific early warnings signs are hard to detect. The increase in RISMAN score of RIS-0331 is elaborated upon in previous paragraphs.

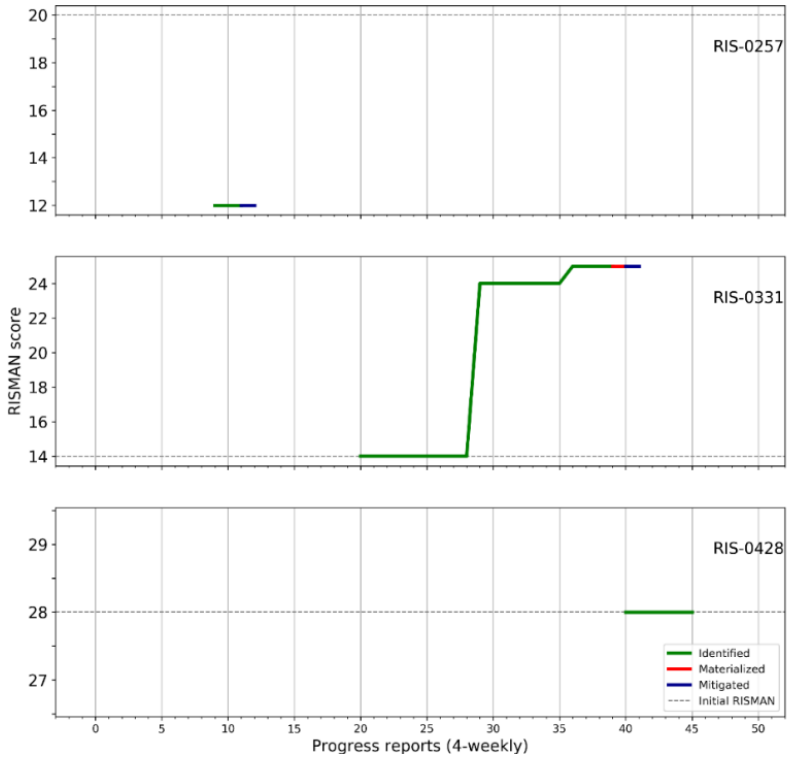


FIGURE 5.30 OVERVIEW OF RISKS (RISMAN AND STATUS) WITH THEME 'ISSUES WITH THIRD PARTIES'

To conclude, in this case study various early warning signs have been detected in hindsight by analysing risks, their status and their RISMAN scores, as well as their causes. First of all, themes were identified based on content and cause analysis. Most of the themes describe a cause or issue that precedes the (potential) materialization of those risks associated with it. The risks and the themes are summarized in Figure 5.31, which show the relationships between the risks and the recognized themes. Figure 5.31 does not have a roof on top of the table, because there were no causal relations found between risks. Considering the themes that result into the most risks (row a and d of Figure 5.31), the general theme comes down to receiving, interpreting or managing information from either client, stakeholders or third parties. In the following section the causes and risks will be analysed more thoroughly to detect early warning signs in this chain of events (before a risk materializes).

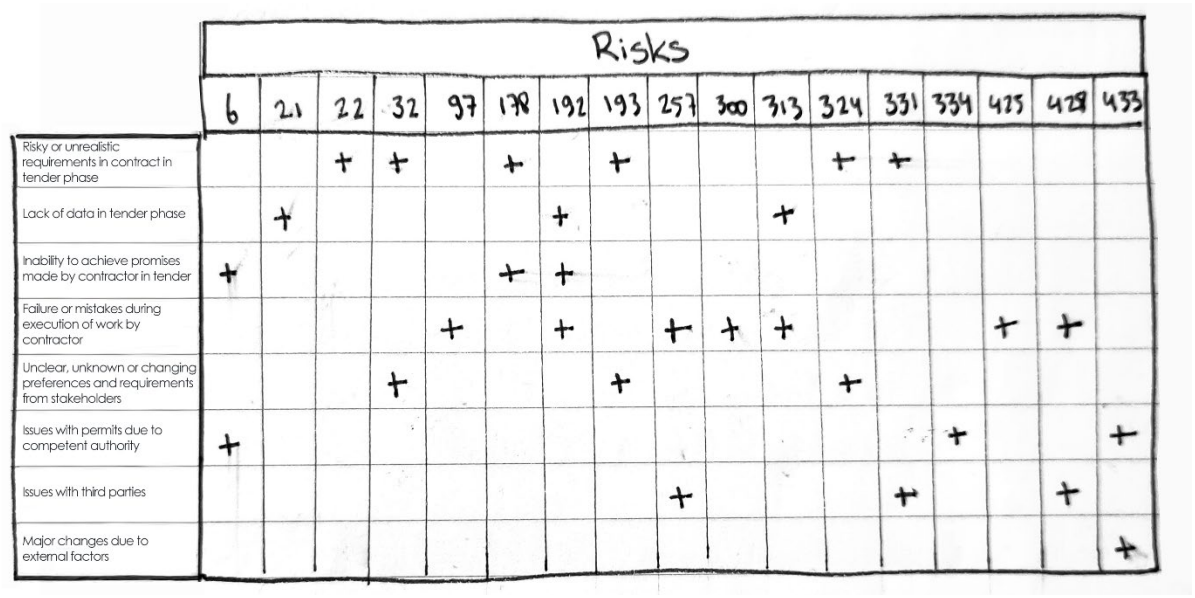


FIGURE 5.31 THEMES AND RISKS RELATION DIAGRAM OOIJEN-WANSSUM

Furthermore, early warning signs were detected in the analysis of RISMAN scores. It is difficult to conclude whether the chronological order in 6 out of 7 of these occurrences (Figure 5.24 until Figure 5.30) really is a cause and effect relationship. However, it can be indicators for reflection and evaluation to avoid similar mistakes in the future.

Moreover, the explanations for incidents with increase in RISMAN score are summarized per risk in Table 5-2. Most risks have the status materialized when the score increases, but for RI-021 the score increases after materialization.

TABLE 5-2 OOIJEN-WANSSUM SUMMARY OF ANOMALIES PER RISK STATUS AND JUSTIFICATION

Status risk when score changed	Risks	urgency/ deadline*	discovery/ changed circumstances*	optimistic estimation*	admin error*
materialized	RI-021			+	
identified	RI-022			+	
identified	RI-032		+		
identified	RIS-0178				+
identified	RIS-0331 (I)		+		
identified	RIS-0331 (II)	+			
identified	RIS-0425				+
	Total	**1**	**2**	**2**	**2**

Remark decreasing RISMAN score of mitigated and materialized risks

When the reported RISMAN score of a materialized risk decreases over time, it is difficult to distinguish between the damage/ consequences of the risk and the current, maybe still relevant exposure of the project. For example, when RIS-0193 materializes the score is 33, so it is expected that the 'harm' to the project is reflected by this score. However, the RISMAN score decreases over time, and eventually gets the status mitigated. So does this mean the 'damage' to the project due to this risk is decreased to 16 (and eventually 8)? Or, does this score reflect the resulting risk, meaning the risk can materialize again and cause more problems for the project?

Remarks about materialized vs mitigated risks

In these figures there is no distinction between preventively and correctively mitigated risks. Additionally, no information could be retrieved on the costs associated with mitigating the risks, e.g. formal or informal mitigation measures. Therefore, no conclusions can be drawn about whether it was beneficial to invest in mitigating the risk compared to the costs of a materialized risk.

6 Discussion

This chapter will reflect on the results from the case studies and review relevant literature about early warning signs in order to answer the research question.

6.1 Identification of Early Warning Signs

From the literature study two identification methods for early warning signs were selected: risk analysis and cause-and-effect analysis. The application of these methods in the case studies showed that early causes and issues are revealed. It is difficult to prove that the presented themes really are early warning signs. On the other hand, the methods generate useful information about the risks and the project, which can be used in further risk management and decision making. From project N244-N246 the themes 'Mistakes made in tender documents', 'Requirements that cannot be met', 'Inexperienced client organization', and 'Client's poor and lengthy decision making process' show potential value as early warning signs. Even the theme 'Issues resulting from own (construction) mistakes' can be an early warning sign for poor execution or poorly skilled or confident personnel, if too many (materialized) risks can be traced back to this theme. For project Ooijen-Wanssum the themes with potential early warning sign value are 'Risky or unrealistic requirements in contract in tender phase', 'Lack of data in tender phase', 'Inability to achieve promises made by contractor in tender', 'Failure or mistakes during execution of work by contractor' and 'Unclear, unknown or changing preferences and requirements from stakeholders'. The themes 'Issues with permits due to competent authority' and 'Issues with third parties' were present too, but less relevant as an early warning sign, because the risks and third parties or authorities are too diverse to treat them alike or assume causal relationships.

6.2 Filters Encountered in Responding to Early Warning Signs

Literature suggests there are three filters that block detection of early warning signs, namely surveillance filter, mentality filter and political/ power filter (Ansoff 1984). An early warning sign must pass all filters before the project team can respond (effectively) (Haji-kazemi 2015). Analysis of the processes in Chapter 4 as well as the case studies in Chapter 5 showed that the project teams were not aware of early warning signs at all. This means that the first filter, surveillance, is the active filter. Overcoming this filter can be done by improving collection and management of information.

6.3 Justification of Increase in RISMAN Scores and Barriers that Block Response to Early Warning Signs

The analysis of risks lead to the discovery of a decent amount of risks that increased in RIMSAN score over time. By means of interviews the reasons for these increase were detected. The findings are summarized in Table 6-1. The most common justification for increase in score is approaching deadlines and therefore the increase of probability of the risk, but also, if the risk materializes just before the deadline, the impact can be larger compared to early materialization. Other frequently identified explanations relate to new estimations (= increase in RISMAN score) made based on newly acquired information or changes in the situation. Another category involves risks that were estimated too optimistically, meaning the consequences turned out to be higher than estimated, while circumstances and information remained identical (unlike the previously mentioned justification). Furthermore, project N244-N246 encountered risks that increased in score due to strategic communication towards the client. This reflects the use of the progress reports as a communication tool. On the contrary, project Ooijen-Wanssum had a consistent and theoretical application of risk management and progress reports. However, two examples of increasing RISMAN score could not be explained with project circumstances, but derived from small administrative errors.

In addition the risk status at the time of increase was examined. The majority has the status identified. Nonetheless, five cases in project N244-N246 show an increase with status mitigated. The reasons derived from Table 6-1 are urgency and strategic communication. The interviews explain this comes from the corrective mitigation measures that are not effective or issues that need to be solved by the client, who does not take (enough) action. The four remaining instances have risk status materialized when the score increases. The reasons for this are diverse and vary from being too optimistic in estimation, due to personal errors or changed circumstances, to approaching deadlines.

TABLE 6-1 SUMMARY OF ALL RISKS ANALYSED DUE TO INCREASE IN RISMAN SCORE

Status risk when score changed	Case Study*	Risks	Urgency/ deadline	Strategic communication	Discovery/ changed circumstances	Optimistic estimation	Administrative error
Identified	N	RIS-0109			+		
Identified	N	RIS-0119 (I)				+	
Materialized	N	RIS-0119 (II)	+				
Materialized	N	RIS-0120			+		
Materialized	N	RIS-0123				+	
Mitigated	N	RIS-0165	+				
Identified	N	RIS-0166	+				
Mitigated	N	RIS-0167		+			
Identified	N	RIS-0173	+				
Mitigated	N	RIS-0174		+			
Mitigated	N	RIS-0176 (I)	+				
Mitigated	N	RIS-0176 (II)	+				
Materialized	O	RI-021				+	
Identified	O	RI-022				+	
Identified	O	RI-032			+		
Identified	O	RIS-0178					+
Identified	O	RIS-0331 (I)			+		
Identified	O	RIS-0331 (II)	+				
Identified	O	RIS-0425					+
		Total	**7**	**2**	**4**	**4**	**2**

*Legend Case Study: [N] N244-N246, [O] Ooijen-Wanssum

The five justifications from Table 6-1 show similarities with the barriers blocking detection of early warning signs discussed in the literature chapter of early warning signs. An earlier study from Wijtenburg on early warning signs suggests that there are eight important barriers that prevent the ability to respond to early warning signs, namely optimism bias, time pressure, project complexity, uncertainty avoidance, fragmentation, client-contractor relation, political effects and management style. The increase in RISMAN due to an approaching deadline implies time pressure, and optimistic estimations can be a result of optimism bias. Additionally, the strategic communication of the project team of N244-N246 is a form of management style that effects the transparency of the data and might block visibility of early warning signs.

Furthermore, from the cause-effect analysis some issues were recognized in the top 8 barriers from Wijtenburg too. The risk managers explained in their interviews how innovative dike design increased project complexity, the large amount of plots that made up the project area results in fragmentation of the project and the decision making of the client caused some problems in the project of N244-N246.

6.4 Project Specific Remarks

6.4.1 N244-N246

In project N244-N246 the effect of mitigation measures is not monitored or evaluated, but the residual risks are directly assumed at 100% efficiency and execution of the mitigation measures. This can make the project team overly optimistic, as the risk scores are lower on paper than they might be in reality. Besides, the risk managers often, but not consistently, used the initial RISMAN score to track the current score, which also limits the information available for decision making and selecting a risk strategy. Secondly, during project execution there were capacity problems at Dura Vermeer, hence risk and project management was not always executed according to standards and the company's processes. Finally, there were many scope changes in the project. Due to incorrect information, documents and demands during the tender & dependency on other projects in the surrounding area. This lead to many changes in the design, new permits to be issued, etc.

6.4.2 Ooijen-Wanssum

Some materialized risks were not mentioned in the progress reports. E.g. RIS-0369, 364, 249, 309, 289, 218. The risk manager explained that the progress reports are means of communication and collaboration with the client. If the responsibility of the risk lies with the contractor, the contractor will take appropriate action and mitigate the risk. It can be possible that the materialized risk is already fully mitigated before the next progress meeting. It is also possible that the risk score (RISMAN) is too low to get in the top 20, and therefore will be left out of the appendix in the progress report. If the risk is important, it can be mentioned during the meeting, and in the comments in the section about risk management, but not in the official top 20 from the progress report. It can be concluded from this finding that the selection of risks from the progress reports as a starting point might not include all mitigated or critical risks, because the contractor is constantly managing the project, which involves solving problems on a daily basis, but not all are reported and discussed with the client, especially when the issue has been mitigated.

7 Expert Session

An expert session with risk managers from Dura Vermeer was organized to discuss the case studies and process improvement mentioned in the previous section. The goal of this session is to verify the processes used in the case studies and discuss the results to improve the current recommendations. The conducted research in chapter 5 included only two projects, so the experience from multiple risk managers across many projects will contribute to this research without having to analyse additional projects separately. Moreover, the processes of Dura Vermeer might have changed last years, and some issues might have been fixed or recommendations might have been implemented already. The session was held on the 29th of October via an online environment, MS Teams. During these 2 hours the research was briefly introduced and concluded with the findings from the case studies. Questions were asked to the 3 risk managers present to verify the risk and contingency processes found at Dura Vermeer, followed by a discussion on the benefits and practical pitfalls of implementing early warning signs, improving cost contingency management and revising current risk management processes.

7.1 Cost Contingency Estimation and Management

Firstly, the cost contingency processes are discussed. The expert confirmed the processes from the case studies and in chapter 4 are correct and used in current projects. However, they addressed a gap between the tender team and the execution team, as not all information about how the estimated cost contingency is shared with the team executing the project. This results in a 'black box' in some cases, in which it is difficult to add the right focus to the project and information might be lost in the transition from one phase to another and from one discipline to another. Furthermore, the cost contingency in the tender phase is estimated based on the identified risks at that time. Nonetheless, the risks that were identified during the execution phase are added to the risk register and both risks are treated indifferently, which means that more risks are added as the project progresses, but need to be paid from the same cost contingency. It was argued that the identified risks during the project execution are a different type of risk, as they are not known yet in the tender phase, and therefore should not be paid from the cost contingency as intended in the early phase. A clear distinction between tender risks and identified risks during project execution can contribute to the understanding of this issue, and prevent underestimating, because two separate cost components will be included in the budget, one for each type of risk.

Secondly, theoretical cost contingency management methods were discussed, as elaborated upon in chapter 2.3. It was found that there is no historical data available to apply methods such as 'value at risk'. In spite of the lack of project data, there is an ambition to generate this over the coming years. The Delphi method is also not promising for practical application, because it requires a lot of (valuable) time and therefore does not fit with the organization's culture. Currently, there is no additional knowledge about simulation techniques other than Monte Carlo simulations. Consequently, the methods from Barraza and Bueno (2007), Hammad, Abbasi and Ryan (2015) and Hammad, Abbasi and Ryan (2016) are discussed, as they are based on Monte Carlo simulations. In general the risk managers disapproved of dividing the total cost contingency over the project activities. This is not how a simulation, like Monte Carlo should be interpreted. In a simulation there are many possible outcomes calculated and in some realities one risk materializes and in another reality another risk materializes. Dividing the cost contingency across activities suggests a false certainty. Moreover, tracking available and needed cost contingency with percentage of completion of the project activity will not work, because the spending pattern does not align with activity progress. Activity progress has a linear timeline, while cost contingency is spend at the beginning or before an activity starts (preventive mitigation measures) or at specific times, mostly at the end of an activity with large amounts, for example when the milestone approaches and the activity is delayed, corrective measures need to be taken.

The current management of cost contingency is also elaborated upon. It was stressed that this task is executed by someone from the financial department from Dura Vermeer, but that the risk managers provide information such as the risk analysis and Monte Carlo distribution. They stated that the initial budget can and will be adjusted during project execution, to fulfil the practical needs and changes in the project. The total amount set to realise this project scope will remain, but the amount of money reserved per component can be moved from one to the other. This redistribution of the budget happens every quarter (3 months) and needs to be confirmed by the management team (MT). Due to the process described in chapter 4.2 and 4.3 and this concept, it is very difficult to track materialized risks and failure costs in the budget. Especially minor failure costs are impossible to document, but can add up to huge cost overruns, which is often seen in labour costs.

The risk managers pointed out that the use of RISMAN scores had developed since the start of these projects. They are currently using three RISMAN scores: initial, current and residual. This provided the risks managers with more info about the start, current and desired score of the risks, where the current score reflects the effectiveness of the mitigation measures. In both case study projects vital information is lost when residual RISMAN is used as current RISMAN. The importance of these three risk scores interrelates with determining the risk strategy. The initial threat is portrayed by the initial RISMAN score and the effect of the mitigation measures is reflected in the residual RISMAN score. The difference between these scores is important input for the decision making process, and risk managers can decide to , for example, accept, mitigate, or transfer the risk. The risk managers explained that there is no standard process for risk strategies, and it is not documented in the risk register. Deciding whether or not to implement measures to mitigate a risk is a subconscious decision making process, in which the highest risks are usually mitigated and lower risks are accepted.

Progress reports are mainly a tool to communicate with the client. This is interpreted differently by different risk managers, and some really use it as a 'tool'. This was visible in the RISMAN scores of the risks in project N244-N246 when the scores of client's risks were raised, even though the risk did not increase. In this specific situation the RISMAN score in the progress report is used to show the client the urgency of the risk and stimulate him to take action. An example is RIS-0167, where the RISMAN score was increased in period 17 to stress the urgency of the issue. This strategic application of risk documentation and progress reports is not favourable and definitely not according to theory and the books, but the risk managers agreed it is tempting to apply and it is sometimes necessary to stress the severity of the risk to the client.

Additionally, the risk managers argued there was no fixed way to report risks in the progress reports and that it very much depends on the requirements in the contract. Some clients want a top 20 with highest scoring risks, others a top 5. One client prefers a selection of risks based on initial RISMAN scores, while another is interested in residual RISMAN scores. After discussing the method used in this research for selecting risks with the risk matrix, they admitted that a top list of risks might not reveal all critical risks and that it could be beneficial for them as contractors to have a more consistent reporting process to gain more control over the project and minimize the chances of overlooking major risks.

While discussing the selection of important and materialized risks, it was pointed out that, despite organized risk sessions, major risks are mainly identified in informal settings in the coffee corner or while walking the corridors of the offices or project site. This was mentioned in literature too (see chapter 3.5) and the power of these informal settings should not be underestimated. As suggested by Holopainen and Toivonen (2012) issues that are discussed here can be early warnings signs, which will be elaborated upon in the next section.

7.2 Common Causes and Early Warning Signs

Finally the 'common cause diagrams' from the case studies are presented and discussed. All in all, the risk managers were positive towards the network analysis and the contribution to the current risk management processes. The approach is promising, because it offers more and thorough information about the risks. This systems perspective is a better representation of reality than individually analysing risks. Additionally, this visualisation can contribute to communication between people from the project team, experts and stakeholders, as well as information transfer between project phases and before or after a risk session. For implementation of this analysis they suggested to do this as soon as possible in the project, because the sooner the information is available, the better, and appropriate actions can be taken. However, they expressed their concerns with large projects, as it becomes harder to manage the large amount of risks, and the execution phase, as more and more risks will be added and changes might happen to the project.

The information and insights generated with this diagram can contribute and strengthen the decision making in multiple ways. One is a the selection of the risk response to determine the risk strategy. When more information about the entire project network is known, links between risks are visualized, as well as multiple causes and consequences. Another benefit is the representation of the chain of events. This allows for mitigation measures to be formulated for causes that happen earlier in the process, rather than the direct cause. An additional approach is increasing the efficiency of mitigation by targeting a common cause with many risks. In that case mitigating one cause decreases the probability of occurrence of various risks.

The risk managers confirmed that there is currently no awareness or implementation of early warning signs in the risk or cost contingency processes. They do, however, monitor key performance indicators, which are lagging indicators for project performance. After clarification of the theoretical concept of leading and lagging project indicators, the risk managers agreed the concept could add value to projects. Nevertheless, they struggled with formulating how the common causes and themes or other early warning signs could be detected and acted upon in their projects. They stressed that it is practical to have a checklist, like KPI's or risks, to be able to implement and manage it. The information should be clearly visible in software tools, dashboard or progress reports, in order to keep focus on them while performing daily project management tasks.

Moreover, it was pointed out that the currently identified themes are clearly deduced from the cause-and-effect analysis, but are difficult to translate to specific early warning signs when the risks include multiple different parties or stakeholders. For example, the theme that merges issues with third parties or competent authorities contains risks with the same theme, but relate to many different individual issues and parties. Therefore, it is hard to find one main reason or mitigation measure to deal with the risks. On the other hand, they argued that it might be an early warning sign if a large amount of (materialized) risks come down to this theme. Then, the problem might be internally, or stakeholder management should generally be improved.

CONCLUSION

8 Conclusion & Recommendations

8.1 Conclusion

The conducted literature and empirical research answer the formulated subquestions of this research and all questions combined will answer the main question of this research: 'How can early warning signs be used in large construction projects to improve accuracy of cost contingency estimates and management in order to minimize cost overruns?'.

8.1.1 Cost Contingency

Subquestions to be answered in this paragraph:

1. *How is a cost contingency determined, monitored and controlled and why is it often inaccurate?*
2. *What is an accurate estimate?*

Contingencies are added to the budget to account for uncertainties and fluctuations by external factors affecting the project. Cost contingency is specifically included in the budget to account for risks and unforeseeable situations within the scope of the project and it should be proportionate to the level of uncertainty of the project. There are three categories of cost contingency estimation methods: deterministic, probabilistic and modern mathematical methods. The most commonly used method is range estimating, a probabilistic method using Monte Carlo simulation to calculate the contingency needed. During project execution the cost contingency is generally managed using the same estimation techniques, but with updated input. Literature offers alternative methods varying from adaptations of the Monte Carlo simulation to completely new methods to calculate 'value at risk' or simulate the decision making process. Most methods use the risk register as input for the simulations are calculations, which reflects the cost contingency needed for identified risks ('known unknowns'). However, the cost contingency should cover both identified and unidentified risks within the project scope.

In order to improve the accuracy of cost contingency estimates, the definition of accuracy and the practical translation to cost contingency estimates is evaluated. An estimate is accurate when it equals the actual cost required at the end of the project. For contractors specifically, it is of high importance to have an accurate cost contingency estimate, because the lowest bidder gets the projects assigned. However, a tight budget increases the risk of cost overrun. Therefore, cost contingency is carefully estimated. However, it is extremely difficult to estimate the budget to the euro specifically. Besides, it is not necessary to estimate super accurately with a small bandwidth, as it takes large quantities of resources to achieve high accuracy. Therefore, margins are added to describe the acceptable deviation from the initial estimate. In cost contingency estimates a confidence interval is selected in such a way that the project team is confident about realising the project within the set budget. The lower the confidence interval, the more risk is accepted, and the higher the confidence interval, the more likely the project will stay within the limits of the budget. 80% is a common confidence interval for cost contingency estimates.

The methods for cost contingency management are available in literature, but are not applied in projects at Dura Vermeer. This gap between theory and practice can explain the reoccurring cost overruns at large infrastructure projects, despite the awareness of uncertainties, acknowledgement of the importance of cost contingency techniques and development of these methods. In literature, three types of challenges are encountered in the estimation process: poor practice and uncertainty, project characteristics and dynamics, and strategic misinterpretations.

8.1.2 Early Warning Signs

Subquestions to be answered in this paragraph:

3. *What are early warning signs and how are they identified?*
4. *Which early warning signs can be found in finished projects?*

Project teams monitor performance indicators, which are lagging indicators providing information about events or activities that happened in the past. It contributes to the learning process, but it does not contribute to proactive management. Leading indicators can function as early warning signs, presenting themselves before the issue arises. Acting upon these signs, e.g. by taking mitigating measures, can reduce the probability or impact of a (risk) event. Early warning signs can contribute to project performance if the response is effective. However, in identifying and responding to early warning signs, there are filters to overcome limiting the flow of information and decision-making. Additionally, barriers are experienced, such as optimism bias, time pressure, project complexity, uncertainty avoidance, fragmentation, client-contractor relation, political effects and management style.

Literature offers multiple methods to detect hard early warning signs. The full list is presented on page 37. In the case study risk analysis and cause-and-effect analysis was successfully used to detect early warning signs. Detecting soft early warnings signs requires other approaches, such as stakeholder feedback and informal discussions. The interviews with the risk managers from the case studies were used as a tool to retrieve these soft early warning signs and other relevant, non-documented data. The risk management experts at Dura Vermeer explained that risk sessions and other forms of interaction internally and externally, as well as small talk at the coffee corner contribute to detecting risks and will probably contribute to early warning signs.

In the case studies early warning signs were detected in different forms. First of all, themes were identified, via cause-and-effect analysis, which contain multiple causes of materialized risks. Examples are ‘errors in tender documents’, ‘lack of data in tender phase’ or ‘inexperienced client organization’. Second, materialization of risks is an indication that some causes have materialized and therefore effect other risks or project aspects. Especially the risks with similar common causes or in the same causal chain of events are likely to be affected by it. Third, an increase in RISMAN score indicates that the situation or interpretation of the situation changed. This is another early warning, like the materialization of a risk, which might lead to materialization of another risk. However, the reason for the increasing RISMAN score can be caused by different origins, for example due to optimistic estimations, strategic communication or an approaching deadline. It is important to analyse these reasons, because they can reveal barriers that block identification and response to early warning signs. The active filter encountered in the case studies, responsible for not being able to act upon early warning signs, is the surveillance filter. Specifically this first filter needs to be deactivated, in order to detect early warning signs.

8.1.3 Improving Current Cost Contingency Process

Subquestions to partly be answered in this paragraph:

5. *How can the current cost contingency process be adjusted to include early warning signs?*

Before process improvements for early warning sign implementation are proposed, some improvements for the cost contingency management process itself are suggested. In order to achieve high levels of accuracy in cost contingency estimates and management, the budget itself has to be managed on a certain level of accuracy as well. This is currently not the case. Therefore it is suggested to improve the consistency and accuracy of the budget and cost components.

There is a large gap between the practical application of cost contingency management process and the processes available in literature. Based on the current process and acknowledged pitfalls, it is recommended to divide the bulk cost contingency among risk causes, work packages, subprojects or another division, depending on the desired level of detail and practical feasibility. This can be updated regularly and redistributed, but it will add focus and more clarity to the bulk cost contingency. It should not be divided across specific risks or activities, because the former is too specific, and the latter has a different spending pattern. Due to this division it becomes easier to track cost contingency, which will generate more knowledge about the actually needed cost contingency. Furthermore, there is currently no distinction between risks that are identified during the tender phase and risks that are identified during the execution phase. Based on the current process, the cost contingency does not cover risks that are identified later, but in practice it is used as such, leading to cost overruns.

Additionally, the accuracy of the estimates and management of cost contingency can be improved by building a database with these tracked cost contingencies, so lessons can be learned from previous projects. Furthermore, tracking contingency and saving it in a database helps to establish baseline contingency amount according to project size and type, and this data is then useful for reference when similar projects arise, which is sometimes referred to as internal benchmarking. This pushes the process to include an 'outside view', which helps to increase the accuracy of the estimates. Finally, the database will reveal the actual cost contingency needed for a project, including all materialized risks, contrary to the current approach in which solely identified risks make up the cost contingency.

8.1.4 Implementing Early Warning Signs in the Cost Contingency Process

Subquestions to partly be answered in this paragraph:

5. *How can the current cost contingency process be adjusted to include early warning signs?*

Early warning signs can be implemented in the cost contingency process by shifting the focus of risk management from mitigating and managing the effects of risks towards the causes of risks. Early warning signs present themselves before the risk materializes, so the events and circumstances prior to the risk should be considered and analysed. Subsequently, risk strategies and mitigation measures can be more effective when aimed at the origin of the issue, instead of the direct issue leading to the risk.

Besides, current risk analysis perceives risks as individual issues, while causes from one risk can be similar for another risk, or one risk can lead to another risk. Early warning signs can show themselves through one risk, for example when it materializes or when the RISMAN score increases, but reveals information about other risks too. Therefore, it is valuable to examine the risks as a system or network, instead of single problems. Consequently, mitigation measures can increase in efficiency, when one cause, leading to multiple risks is targeted.

The identification of early warning signs is possible with risk analysis and cause-and-effect analysis, but literature from Haji-Kazemi offers more methods that can help in identifying early warning signs. However, most early warning signs have a 'soft' character, and (like suggested in the interviews and expert session) will present themselves in the coffee corner chat, lunchroom, or informal conversations. Awareness of this is important.

Implementation of early warning signs in the cost contingency process by means of system thinking and focus on causes can contribute to communication between people working on the project. More information can easily be shared about the context of the risks, which benefits the transfer of information between disciplines, successors or with the client or stakeholders.

Most importantly, risk management, cost contingency management, early warning signs and other management processes and tools should support project management and execution. It is essential, especially for contractors, to have good and simple methods, that are efficient and generate enough information to use for decision making and project management in order to successfully execute a project.

> ***"Complex models would not be the solution either for a contingency management approach, as if a model is found conceptually too complex, or if it takes a lot of time for decision maker to analyse the information obtained from it, such a model will have no value for practice."***
>
> ***Barraza and Bueno2007 (p. 104)***

8.2 Recommendations for Practice

Based on the conclusions and findings in this research, these recommendations are made to implement early warning signs in the cost contingency process, which will increase accuracy of the cost estimates.

The basis of cost contingency is in risk management. Therefore, the first set of recommendations are proposed to improve risk management. When reporting risks (internally or externally) it is recommended to agree on a minimum (current or residual) RISMAN score, instead of a top 10 or top 20, because a minimum score (for example based on RISMAN or a risk matrix) represents all critical or major risks, while the top of a list might only show a some of them. Secondly, the use of risk status should be redefined and consistently applied in the projects. It is beneficial for the project itself as well as future references or research to have a set of risk status, corresponding with expectations. For example, a risk with status mitigated, should keep the RISMAN score or decrease. And when it increases alarm bells should ring. Deviations from the expectations, like increase in score while status mitigated, are more clear when the status is applied consistently throughout the project. Thirdly, it is advised to implement the selected risk strategy in the risk register (Relatics), so the risk manager is forced to actively choose what to do with a risk: accept, mitigate, transfer, etc., and the selected risk strategy can be reviewed during project execution, for example, to check if the mitigation was effective or the strategy is still relevant.

The cost contingency process itself is analysed thoroughly in literature and practice. The following recommendations are ensued. Practice uses bulk cost contingency, while literature shows benefits for dividing it into smaller contingencies. These contingencies should not be executed on a risk or task level, but on higher levels, like themes, work packages or project phases and supported by decisions deduced from extensive risk analysis and, for example, Tornado diagrams, which show the risks with the greatest

impact on the project. The aim of this division is to add focus and generate more insight and understanding of the cost contingency and risks, and thus avoiding the black box with money that can be used in case the project fails. Furthermore, a division between identified and unidentified risks in the tender phase is proposed, as the current method for determining cost contingency does not include these unidentified risks. Risks identified during the execution phase are equally important, but are not considered in current estimations. Additionally, reasoning for risk related choices should be documented more extensively in the tender phase, so risk managers in the execution phase understand the built up of the cost contingency, and choices made. This will contribute to better understanding of the project and its risks and enables information and especially early warning signs to be transferred to the next risk manager.

While systematic errors can be minimized by focussing on proper execution of project management, non-systematic errors can be reduced by taking an 'outside view', for example by means of using historical data, or external experts as reference for the estimations. Therefore it is recommended to create a database that includes many projects with their initial estimates for risks and the budget, and the project result, including the costs and materialized risks. This approach enables evaluation of the project itself and the ability to reference other projects when making new estimates. Besides, this database improves the collection and management of data, which helps to overcome the first filter, that is currently blocking early warning signs. Other methods for implementing an outside view, like benchmarking, can be considered to improve the accuracy of cost contingency estimates as well. However, external benchmarking specifically requires data and insight from other companies about their cost estimates. Due to the competitive market it is considered unrealistic to retrieve data about cost estimates from other contractors in the infrastructure sector.

Following from the conclusion, it is recommended to focus on causes of risks and consider risks as part of a network to increase the ability to observe and act upon early warning signs. First of all, it is advised to execute a cause-and-effect analysis with all risks in the tender phase. From this analysis main causes and themes can be derived, which can help in selecting risks strategy and composing a list of indicators to look out for during project execution. For example, if many risks share the theme 'stakeholders', it is wise to reserve some additional money for stakeholder management, or if many risks emerge from a specific task, extra mitigation measures can be taken to minimize the mistakes made and issues arising during execution of that task. Knowledge about causes of risks increase proactive management, effectivity and efficiency.

Secondly, the risk register (tool) should be updated to support the shifted focus to causes and networks. The current software, Relatics, allows risks to be linked to causes, and this need to be used more extensively. The cause-and-effect diagrams need to be translated to Relatics, which means that some causes result in other causes, which result in risks. These layers and succession of events need to be implemented to represent realistic links. Those causes need to be managed too. Therefore, individual mitigation measures will be connected to specific causes, so when the mitigation measure are effective, the cause will be eliminated. For that reason it is important to have some status or other indication for the cause, so risk managers can track the causes and differentiate between active and eliminated causes.

Finally, two early warning signs are identified in the case studies that will help risk management and cost contingency management. When a risk materializes or shows an increase in RISMAN score, the risk manager should be triggered to check, not just the effects on the risk itself, but on other risks in the project as well. Evaluation of the project is needed to deduct what has changed to lead to the materialization or increase in score, and how that affects other risks. It is recommended to re-evaluate or execute the cause-and-effect analysis again as a tool to find the consequences.

8.3 Recommendations for Future Research

Future research with more time available for execution could repeat this research and analyse all materialized risks, or literally all risks of the project. This is valuable, because it can confirm the findings in this research and check whether it is still valid when the entire project dynamic is considered. To avoid limitations in data it is recommended to monitor a project during the execution phase and track and evaluate the data parallel to the execution. Furthermore, the effect of responding to early warning signs can be tested by doing a pilot with the suggested process improvements. This research could show if early warning signs contribute to reducing cost overruns.

It is recommended to do research into the use of other early warning sign identification. This research only considered risk analysis and cause-and effect analysis, but there are more methods known in literature, which can be tested to discover their added value for the project and in finding early warning signs. Likewise, other 'common' items can be identified. This research mainly focussed on the causes, because they precede the risks in chronological order, but risks relating to the same object, project activity, risk owner, project phase, etc. might be valuable information to map and consider as early warning too.

This research is based on data from the risk register and progress reports, but has a qualitative nature. It is advised for future research to look into the quantitative aspect of the causal relationships between causes and risks and how they relate to early warning signs.

During this research it was found that there is no process on how to document and track cost contingency or more specifically failure costs, while being applicable for execution and the efficiency ambitions of contractors. Research into this topic and the development of a process could provide more information on the complex topic of failure costs, which could lead to a follow-up research on how to manage the failure costs specifically.

9 Reflection

Personally, I enjoyed conducting this research as part of my master programme at the TU Delft. The part I enjoyed most was the preparation phase in which I had to find a research topic and formulate a research question. It was interesting to find out what we know about risk management so far and how it is currently applied in practice. These two perspectives broadened my horizon, which was originally limited to the theoretical textbooks and lectures on the topic of risk management. Due to my diverse interest in the topic, it was difficult to limit the amount of papers to read and questions to ask in the interviews. The curiosity from the early stages of the research caused some distractions or days of reading or discussing super interesting, but irrelevant issues for this research. If I were to do the research again, I would set a clearer scope and stick to it. On the other hand, this deviation from the research and main topic lead to a thorough understanding of the topic and its context, as well as the context of the practical application of risk and project management at Dura Vermeer, which is very valuable to me as an individual starting my career, but less relevant for research.

9.1 Insufficient and inconsistent documentation of cost contingency in practice to execute thorough research about accuracy

It is difficult to analyse the cost contingency throughout the project, as the budget is not consistently documented. Cost contingency is included in the budget, but changes are not carefully tracked. Minor costs due to risks or other issues are documented at the cost elements ('bewakingsposten') itself, and only if needed, some money is relocated from the cost contingency to other parts of the budget. But how and why money is shifted within the budget is not documented. Therefore, it is not possible to analyse the use of cost contingency when a project is finished. This was also found by another researcher at Dura Vermeer, who stated: "the made costs due to risks, these are not consistently booked in the risk reserve budget line of the cost control document" (Veen 2018, p. 97). Nonetheless, a cost controller from Dura Vermeer explained that *"It takes a lot of time to make sure every little cost is documented correctly, and it barely benefits me or the project to have such a high level of detail. As long as the final sum adds up, the project is okay and the budget is satisfactory".*

Moreover, the documentation of the budget is inconsistent, due to minor mistakes in documenting costs at specific cost components. According to the project controller (in charge of managing the budget during project execution) it is too much work to correct all mistakes. The objective of managing the budget is that the end result should reflect the right amount of money, and this is obtained by roughly having the right amount per cost component. This makes the current documentation of the budget unsuitable for this research, because failure costs and costs from cost contingency are invisible or untraceable.

However, it would still be interesting to analyse this part of the budget. Since it is not possible to do this with finished projects, due to the aforementioned reasons, two improvements are suggested. One option is to conduct the research parallel to the execution of a project. With this approach the required data and structure in the budget can be documented to suit the research. Another possibility is to make some changes in the documentation of Dura Vermeer's process, so all new projects will document the cost contingency and failure costs regularly and consistently.

9.2 Risks & Opportunities

It was a personal ambition to include both risks and opportunities. However, there is a lot less thought given to opportunities. They are not treated and managed as thoroughly as risks are. Therefore, there were

only 2 opportunities documented per case study, and no further analysis, mitigation measures, or other notes about the opportunities were executed or documented. In order to include opportunities in this research or do a proper analysis, more than a few instances are needed. Also, without treating it the same as risks during project execution, meaning they are actively managed, you cannot treat them similarly in research.

9.3 Processing Data

In hindside, the research goal to improve accuracy by looking at early warning signs was quite a vague starting point to collect or process data. Both risks and the budget is managed and documented during project execution, but how to detect early warning signs from it, is an entirely new question. The company was not aware and had no such concept implemented in their project management processes, so I had to start from scratch. I had to get familiar with risk management in practice and understand the process, before I could start looking for early warning signs. This lead to many meetings with employees and sometimes also retrieving and analysing data I did not need in the end. Besides the issues described in paragraph 9.1, and the available documentation of risks, in Relatics and progress reports, were limiting too. The structure of those tools are designed to facilitate the execution of a project, not to retrieve specific data. Therefore, I had to be creative in selecting risks, but also had to rewrite and restructure the data manually, which was a very time consuming task. If I were to do this research again, I would be able to find the data about risks (RISMAN scores, status, causes, etc) a lot easier, as I am familiar with the tools, documentation and processes. However, it would be way easier if the tools would allow for more convenient export of data, or conduct this research parallel to the execution phase of the project, so the data can be stored and updated as the project develops.

9.4 Analyse all project risks

Due to time limits and the purpose of this research it was not realistic to analyse all project risks. However, it would be very interesting to get more information and understanding about the project dynamics. In this research there are probably many things skipped or missed due to limited amount of risks analysed. I assume it will generate a more complete and coherent analysis, which is more realistic than this one.

9.5 Expert Session

The expert session was organized after the results from the case studies were analysed, but before the discussion and conclusion were written. After the session and discussions with the graduation committee, the discussion and conclusion kept being developed and improved. This increased the quality of the research, but meant that the experts did not comment on all results produced by this research. Unfortunately, there was no time left to organize another expert session to validate the second set of conclusions and especially the recommendations. However, during informal and non-documented conversations with the risk managers at Dura Vermeer, for example the interviewees from the case studies, the new conclusions and recommendations were discussed. The response to the recommendations was positive and could, according to them, contribute to improving their risk management. After the final report is handed in, the results of this research will be presented to the risk management experts at Dura Vermeer to ensure the information is transferred and knowledge is gained by the organization.

9.6 Assessment of Risks

In this project the assessment of risks is done with a RISMAN score, which includes probability and consequences in a semi-quantitative way. It is a common method in the construction sector. However, other indicators are used to express risks as well, for example cost estimates. The recommendation of tracking the assessment of risks is this applicable, even though other assessments than RISMAN are used.

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APPENDICES

1 N244-N246: Data Extracted from Progress Reports

VGR	1	2	3	4	5	6	7	8	9	10	11	12	13
Totaal risico													
voorstel													
beheerst													
vervallen													
totale score (pre-mitigatie) risicodossier													
n (risico's)													
Risico													
RIS-0004		0	0										
RIS-0005		0											
RIS-0006		0	0										
RIS-0007		0											
RIS-0008		0											
RIS-0009		0											
RIS-0010		0											
RIS-0011		0											
RIS-0012		0											
RIS-0013		0	0	14	18	18	18	18	18				
RIS-0014		0	0										
RIS-0015		0	0										
RIS-0016		0	0										
RIS-0017		0											
RIS-0018		0											
RIS-0019		0											
RIS-0020		0											
RIS-0021		0	0	14	18	18	18	18	18				
RIS-0022		0	0										
RIS-0023		0											
RIS-0024		0											
RIS-0025		0											
RIS-0026		0											
RIS-0027		0											
RIS-0028		0											
RIS-0029			0	12									
RIS-0031			0		16	16	16	16					
RIS-0033				14									
RIS-0041				10	20								
RIS-0045				16	16		16	16					
RIS-0047				15	15								
RIS-0048				12									
RIS-0052					15								
RIS-0059									18				
RIS-0063				14	14								
RIS-0066				10									
RIS-0068						24							
RIS-0077							15						
RIS-0095													
RIS-0097													
RIS-0099						16	16	16					
RIS-0100					27	27	27		27				
RIS-0101						28							
RIS-0102						18	18	18	18				
RIS-0105										35	35	35	
RIS-0104					18	18							
RIS-0107						18	18	18	18				
RIS-0109							15	15					
RIS-0113													
RIS-0115										75	75	75	
RIS-0116										35	35	35	
RIS-0117										28	28		
RIS-0118													
RIS-0119									40	40	40	40	
RIS-0120									40	40	40	40	
RIS-0121								18					
RIS-0123										70	70	70	
RIS-0124										35	35	35	
RIS-0125									36	36	36	36	
RIS-0126									56	56	56	56	
RIS-0150													
RIS-0151													
RIS-0163													
RIS-0165													
RIS-0166													
RIS-0167													
RIS-0168													
RIS-0170													
RIS-0171													
RIS-0172													
RIS-0173													
RIS-0174													
RIS-0175													
RIS-0176													
RIS-0177													
RIS-0179													
RIS-0180													
RIS-0181													
RIS-0183													
RIS-0184													
RIS-0185													

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
		114	121	125	125		127	127		132	132	132	132	132	
		10	9	10	5		4	4		0	0	0	0	0	
		36	30	29	25		19	19		17	16	15	9	9	
		68	82	86	95		104	104		115	116	117	123	123	
		965	999	1269	1044		664	664		464	440	301	135	135	
		46	39	39	30		23	23		17	16	15	9	9	
				x											
					x										
													x	x	
					x										
					x										
			x												
			x												
										38	38	24	24	24	
												x			
			x												
			39	54	72		x	x							
			36				x	x		x					
					x										
							x	x							
										x			x	x	
		54			54		x	x							
			24				22	22		x					
											x				
					42		28	28		28	28	22	20	20	
			x												
				x											
													x	x	
		75	75	75	30										
		63	63	72	x										
			85	x											
		70	70	80	80		80	80		80	80	36	36	36	
		52		x											
				24											
			39		26								16	16	
			60	60	60		x	x							
			50				50	50		50	50	30	x	x	
			55	65	65		26	26					6	6	
				44	22		11	11					5	5	
				44			55	55		x					
				48			48	48		x					
				39											
				24											
				24											
							90	90		x					
							40	40		40	40	20	x	x	
													12	12	

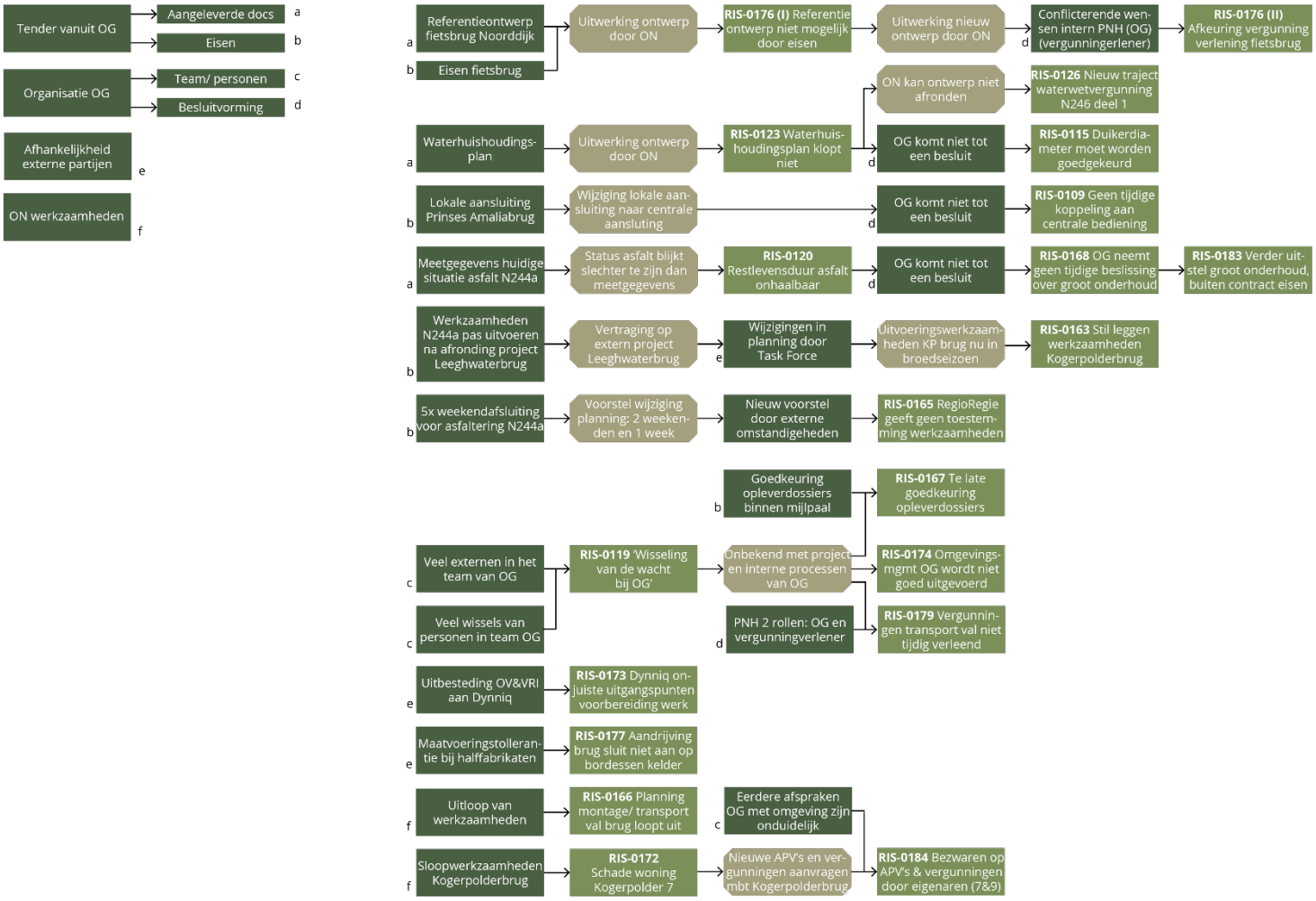
2 N244-N246: Short list Risks Selected for Analysis

Risk (code)	RISMAN score (highest)	Condition	Colour code in risk matrix (red/ yellow/ green)
RIS-0063	72	>65	red
RIS-0109	54	>39	yellow
RIS-0115	75	>65	red
RIS-0119	42	>39	yellow
RIS-0120	40	>28 with P4	yellow
RIS-0123	70	>65	red
RIS-0126	56	>39	yellow
RIS-0163	75	>65	red
RIS-0165	72	>65	red
RIS-0166	85	>65	red
RIS-0167	80	>65	red
RIS-0168	52	>39	yellow
RIS-0171	39	>39	yellow
RIS-0172	60	>39	yellow
RIS-0173	50	>39	yellow
RIS-0174	65	>65	red
RIS-0175	44	>39	yellow
RIS-0176	55	>39	yellow
RIS-0177	48	>39	yellow
RIS-0179	39	>39	yellow
RIS-0183	90	>65	red
RIS-0184	40	>39	yellow

Notes:

The risks highlighted in grey are not selected for further analysis due to administrative errors. Administrative errors are considered inconsistent use of RISMAN scores or difficulty in reconstructing the risk over time, even after interviews.

3 N244-N246: Diagram Risk Causes



Notes:

Dark green = cause

Light green = risk

Grey with corners = additional activity to complete the cause-effect chain (additional info)

4 N244-N246: Timeline Risk Score and Status for each Theme

VGR		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Datum		22dec2017	1feb2018	15mrt2018	13apr2018	10mei2018	7jun2018	5jul2018	2aug2018	30aug2018	27sep2018	25okt2018	22nov2018	18dec2018	17jan2019	14feb2019	14mrt2019	11apr2019	9mei2019	6jun2019	4jul2019	31jul2019	29aug2019	26sep2019	24okt2019	21nov2019	19dec2019	16jan2020	14feb2020	12mrt2020
Mistakes made in tender documents																														
RIS-0115	initial RISMAN											75	75	75	75	75	75	75												
RIS-0115	residual RISMAN																													
RIS-0115	Status								1			4						9												
RIS-0120	initial RISMAN								40	40	90	90	85	85	85	85	85	85												
RIS-0120	residual RISMAN									40	40	40	40	40	40	40	40	40												
RIS-0120	Status								4									9												
RIS-0123	initial RISMAN									10	70	70	70	70	70	70	70	70												
RIS-0123	residual RISMAN																													
RIS-0123	Status									1	4							9												
RIS-0126	initial RISMAN									60	60	60	60	60	60	60	60	60												
RIS-0126	residual RISMAN									56	56	52	52	52	52	52	52	52												
RIS-0126	Status									2								9												
RIS-0168	initial RISMAN																	52	52	52										
RIS-0168	residual RISMAN																													
RIS-0168	Status																1			9										
RIS-0176	initial RISMAN																		33	44	44	44	55	55	55	55				
RIS-0176	residual RISMAN																													
RIS-0176	Status																	6								9				
RIS-0183	initial RISMAN																						90	90	90	90				
RIS-0183	residual RISMAN																						90	90	90	90				
RIS-0183	Status																				1	6				9				
Requirements that cannot be met																														
RIS-0109	initieel RISMAN							24	24	24	24	72	72	72	72	72	72	54	54	54	54	54	54							
RIS-0109	rest RISMAN							15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15							
RIS-0109	Status							2						4				6					9							
RIS-0163	initieel RISMAN														75	75	75	75	75	75	30									
RIS-0163	rest RISMAN																													
RIS-0163	Status													1				6								9				
RIS-0165	initieel RISMAN																	63	63	72	72									
RIS-0165	rest RISMAN																													
RIS-0165	Status																	2	6		9									
RIS-0167	initieel RISMAN																	70	70	80	80	80	80	80	80	80	80	48	36	
RIS-0167	rest RISMAN																	42	42	42	42	42	42	42	42	42	42	42	33	
RIS-0167	Status																	6												
Inexperienced client organization																														
RIS-0119	initieel RISMAN									40	40	45	45	45	45	45	45	45	45	70	42	42	28	28	28	28	28	28	20	
RIS-0119	rest RISMAN										40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	16		
RIS-0119	Status									1	2	4						6												
RIS-0174	initieel RISMAN																		55	65	65	65	26	26	26	26	26	9	6	
RIS-0174	rest RISMAN																													
RIS-0174	Status																	6												
RIS-0179	initieel RISMAN																			39	39	39	39	39	39	39				
RIS-0179	rest RISMAN																													
RIS-0179	Status																			1						9				
RIS-0184	initieel RISMAN																						40	40	40	40	40	30		
RIS-0184	rest RISMAN																													
RIS-0184	Status																					1	6					9		
Client's poor and lengthy decision making process																														
RIS-0109	initieel RISMAN							24	24	24	24	72	72	72	72	72	72	54	54	54	54	54	54							
RIS-0109	rest RISMAN							15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15							
RIS-0109	Status							2						4				6					9							
RIS-0115	initieel RISMAN											75	75	75	75	75	75	75												
RIS-0115	rest RISMAN																													
RIS-0115	Status								1			4						9												
RIS-0126	initieel RISMAN										60	60	60	60	60	60	60	60												
RIS-0126	rest RISMAN										56	56	52	52	52	52	52	52												
RIS-0126	Status										2							9												
RIS-0168	initieel RISMAN																	52	52	52										
RIS-0168	rest RISMAN																													
RIS-0168	Status																	1		9										
RIS-0176	initieel RISMAN																		33	44	44	44	55							
RIS-0176	rest RISMAN																													
RIS-0176	Status																	6								9				
RIS-0179	initieel RISMAN																			39	39	39	39	39	39	39				
RIS-0179	rest RISMAN																													
RIS-0179	Status																			1						9				
RIS-0183	initieel RISMAN																						90	90	90	90				
RIS-0183	rest RISMAN																						90	90	90	90				
RIS-0183	Status																				1	6				9				
Issues caused by third parties																														
RIS-0163	initieel RISMAN														75	75	75	75	75	75	30	30	30	30	30	30				
RIS-0163	rest RISMAN																													
RIS-0163	Status													1				6								9				
RIS-0173	initieel RISMAN																		50	50	50	50	40	40	40	50	50	40	40	
RIS-0173	rest RISMAN																													
RIS-0173	Status																	6											9	
RIS-0177	initieel RISMAN																			48	48	48	48	48	48	48				
RIS-0177	rest RISMAN																				10	10	10	10	10	10				
RIS-0177	Status																			1	6					9				
Issues resulting from own (construction) mistakes																														
RIS-0165	initieel RISMAN																	63	63	72	72									
RIS-0165	rest RISMAN																													
RIS-0165	Status																	2	6		9									
RIS-0166	initieel RISMAN																	32	32	85										
RIS-0166	rest RISMAN																													
RIS-0166	Status																	1		9										
RIS-0172	initieel RISMAN																		60	60	60	60	60							
RIS-0172	rest RISMAN																													
RIS-0172	Status																	6					9							
RIS-0184	initieel RISMAN																						40	40	40	40	40	30		
RIS-0184	rest RISMAN																													
RIS-0184	Status																					1	6					9		

Notes:

Risk status: identification (1), materialization (4), mitigated (6), neglected (9)

5 N244-N246: Remarks for increasing RISMAN scores

Risico	VGR	Risk status	Toename	Algemeen	Uit interviews
RIS-0109	10	geidentificeerd	toename G, I, O, T	discovery/ changed circumstances	ON kwam erachter dat er nog geen glasvezel lag: OG had gelogen/ taken niet uitgevoerd: nu komen werkzaamheden in de problemen
RIS-0119	10	opgetreden	toename T	optimistic estimation	Er was toen een nieuwe contractmanager aangeschoven en een technisch manager werd vervangen. Toen werden toetstermijnen door OG overschreden en waren wij veel tijd kwijt aan het meenemen van de nieuwe medewerkers van OG. Wij verloren toen onze buffers aan problemen van OG.
RIS-0119	18	beheerst	toename I, O	urgency/ deadline	Als gevolg van voorgaande maakte we ons zorgen over het halen van de mijlpaal rondom de ingebruikname van de Prinses Amaliabrug. OG was toentertijd meer met zichzelf bezig dan met de voortgang van het project.
RIS-0120	10	opgetreden	toename P, G, I, O, T	discovery/ changed circumstances	Wij hebben de informatie van OG gecontroleerd rondom de kwaliteit van het asfalt van de N244a. Dit bleek veel slechter te zijn, en daardoor moest er veel meer onderhoud uitgevoerd te worden.
RIS-0165	18	beheerst	toename P, G, T	urgency/ deadline	deadline nadert (P omhoog), meer inzicht in gevolgen (c neemt af), totaal is toename risico
RIS-0166	18	geidentificeerd	toename P, G, I, O, V + afname K	urgency/ deadline	naderende deadline
RIS-0167	17	beheerst	toename P	strategic communication	OG wilde geen actie ondernemen
RIS-0173	24	geidentificeerd	toename P	urgency/ deadline	Dynniq liet weer eens zien dat ze hun eigen werkzaamheden niet konden plannen. De coordinatie bij de Kogerpolderbrug dreigde nog verder in de soep te lopen en trad eigenlijk gewoon op.
RIS-0174	18	beheerst	toename G, O	strategic communication	risico is eigenlijk al opgetreden! Daarom is het geindentificeerd (status beheerst wordt gebruikt omdat ON ervanuit gaat dat OG het meteen oppakt). Score in P17 is ervanuit gaande dat OG er na het voortgangsoverleg mee aan de slag gaat. Maar dat gebeurt niet, dus risico score neemt toe, om urgnetie bij OG te benadrukken
RIS-0176	18	beheerst	toename P	urgency/ deadline	geen goedkeuring, intern conflict OG, deadline nadert
RIS-0176	21	beheerst	toename P	urgency/ deadline	geen goedkeuring, intern conflict OG, deadline nadert

6 Ooijen-Wanssum: Data Extracted from Progress Reports

Termijn		VO 1	VO 2	VO 3	VO 4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Start		6-10-2016	3-11-2016	1-12-2016	29-12-2016	26-1-2017	23-2-2017	22-3-2017	20-4-2017	18-5-2017	15-6-2017	13-7-2017	10-8-2017	7-9-2017	5-10-2017	2-11-2017	30-11-2017	28-12-2017	25-1-2018	22-2-2018	22-3-2018	19-4-2018	17-5-2018	14-6-2018	12-7-2018	9-8-2018	6-9-2018	4-10-2018	1-11-2018
Eind		2-11-2016	30-11-2016	28-12-2016	25-1-2017	22-2-2017	22-3-2017	19-4-2017	17-5-2017	14-6-2017	12-7-2017	9-8-2017	6-9-2017	4-10-2017	1-11-2017	29-11-2017	27-12-2017	24-1-2018	21-2-2018	21-3-2018	18-4-2018	16-5-2018	13-6-2018	11-7-2018	8-8-2018	5-9-2018	3-10-2018	31-10-2018	28-11-2018
RI-002			24	24				21	21	21			21																
RI-006			52	52	52	52	52	39	39	26	26	26	26									26							
RI-009														20	24	20													
RI-018			36	36	36	36	36																						
RI-022			27	27	32	32	32	32	32	32												32							
RI-025														20															
RI-029																		18											
RI-032																18													
RI-035			24	24				24	24	24			24	24	24	24	24	24											
RI-036			40	40	40	40	40	30	30	24																			
RI-037																													
RI-048																													
RI-049							30																						
RI-050																20	20	20	20	20	20								
RI-055																												18	18
RI-077								24	24																				
RI-082																											16		
RI-086			24	24	24	24																							
RI-093																													
RI-100															18														
RI-111								24																				16	
RI-114																												16	
RI-116																	18	18		18	18		18	18	18	18	18	18	18
RI-129			40																										
RI-131			36	36	36	36	36																						
RI-133			40																		24	24	24	24	24	24	24	24	
RIS-0151								28	28	28	28	28	28	28	32														
RIS-0152																24	24	24	24	24	24	24							
RIS-0157						27	27																18	18	18	24	24	24	
RIS-0159								21	21																				
RIS-0162				24	33	33	33																						
RIS-0164				27	27	24		24	24	36	36	36	32	21															
RIS-0165							40	30	30	30	30	30	24									24							
RIS-0166					33	33	33																						
RIS-0167					30	30	30																						
RIS-0168					30	30	30			20	30	30	40																
RIS-0169					36	26							52																
RIS-0170					33	27	27	27	27	27	27	27	27	27	18														
RIS-0171					30			22	22	22			22	22	21	21	21												
RIS-0172					24																								
RIS-0173					24	24																							
RIS-0176					36			36	36	36	36	36	48																
RIS-0177					27	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	27	27	27	27	27	27	27	
RIS-0181					39	39	36			20																		16	16
RIS-0182															18	18										18	18	18	18
RIS-0183					26	26					26	26	52																
RIS_0188							27				27	27																	
RIS-0189						28	28	24			28	28		20															
RIS-0190						36	36	24																					
RIS-0193							33	22	22	22			22	22	22	22	22	22	22	22	22	22	22	22	22	22	22		16
RIS-0198								24	24																				
RIS-0199								33	33	33	33	33	27																
RIS-0204																													
RIS-0207									24	24			21	21															
RIS-0209															19	19	19	19	19	19	19		19	19	19	19	19	19	19
RIS-0210									24	24	30	30	30	30	30							30							
RIS-0211									36	30	30	30	30	30								30							
RIS-0212																							16	16	16				
RIS-0213															18														
RIS-0214										24			24									24							
RIS-0218											25	25										25							
RIS-0227											30	30	40																
RIS-0228											26	26																	
RIS-0229											27	27																	
RIS-0230											27	27																	
RIS-0233											24	24																	
RIS-0235															18														
RIS-0239														25								25				24	24	28	
RIS-0248																													
RIS-0252														21	21	21	21	21	21										
RIS-0254																	21	21	21	21	21	21	21	21	21	21	21		
RIS-0260																				18	18		18						
RIS-0267															18	18	18												
RIS-0273																													20
RIS-0279																18													
RIS-0282																21	18	18	18	24	24	24	24	24	24	24	18	18	18
RIS-0283																18	18												
RIS-0289																	20	20	20	20	20		20	20	20				
RIS-0295																		20											
RIS-0296																			20	20	20		20	20	20	20	16		
RIS-0298																		20	20	20	20								
RIS-0309																											16		
RIS-0310																			24	24			28	21	21	21			
RIS-0311																			20	20	20								
RIS-0312																			24	24									
RIS-0314																					30	40	40	16	16			21	21
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RIS-0433																													
RIS-0434																													
RIS-0435																													

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29-11-2018	27-12-2018	24-1-2019	21-2-2019	21-3-2019	18-4-2019	16-5-2019	13-6-2019	11-7-2019	8-8-2019	5-9-2019	3-10-2019	31-10-2019	28-11-2019	26-12-2019	23-1-2020	20-2-2020	19-3-2020	16-4-2020	14-5-2020	11-6-2020	9-7-2020	6-8-2020	3-9-2020	1-10-2020	29-10-2020	26-11-2020	24-12-2020	21-1-2021	18-2-2021	18-3-2021
26-12-2018	23-1-2019	20-2-2019	20-3-2019	17-4-2019	15-5-2019	12-6-2019	10-7-2019	7-8-2019	4-9-2019	2-10-2019	30-10-2019	27-11-2019	25-12-2019	22-1-2020	19-2-2020	18-3-2020	15-4-2020	13-5-2020	10-6-2020	8-7-2020	5-8-2020	2-9-2020	30-9-2020	24-10-2020	25-11-2020	23-12-2020	20-1-2021	17-2-2021	14-4-2021	16-4-2021
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	36	36		36	36	24	24																							
	20																			18			12							
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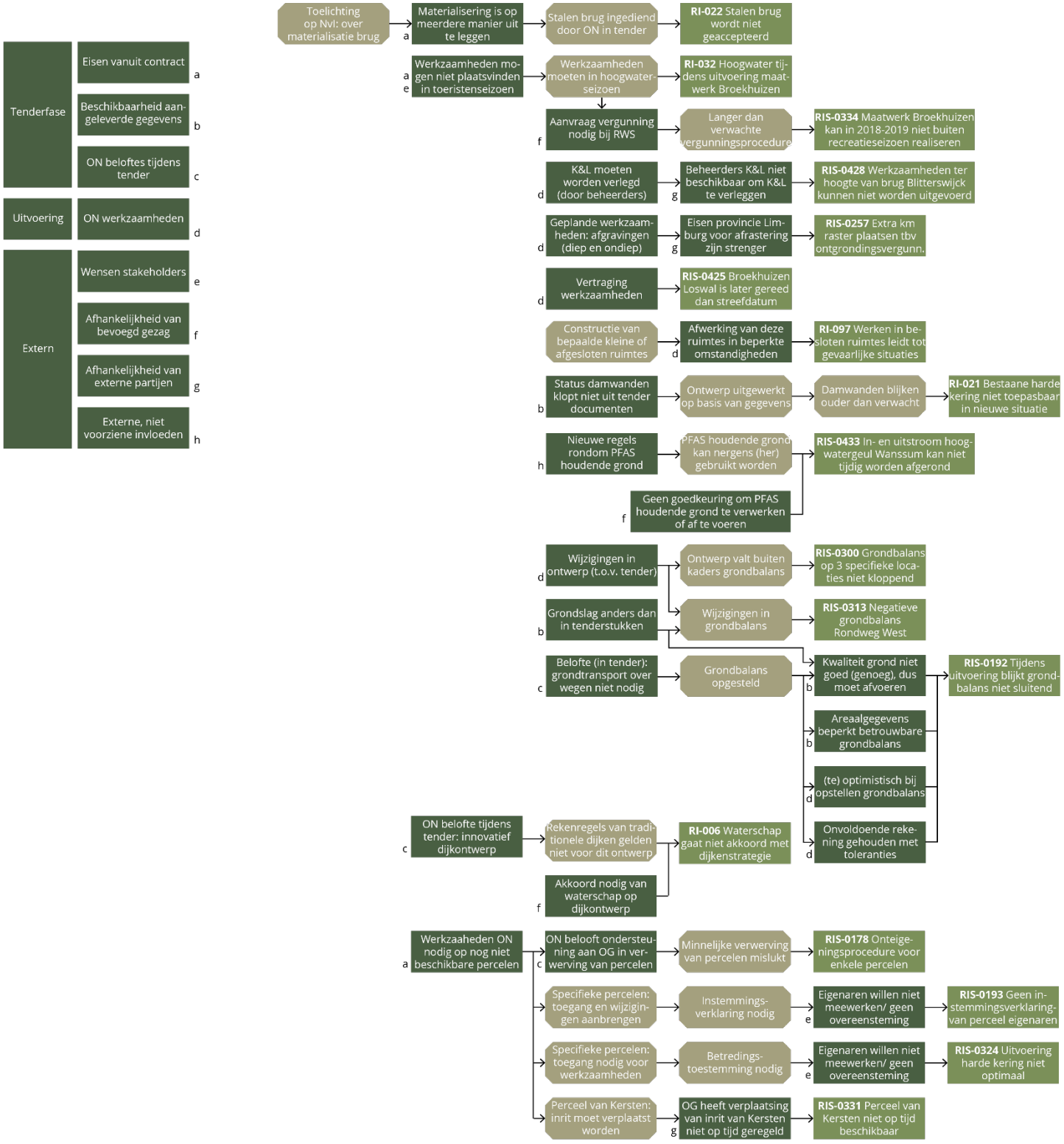
7 Ooijen-Wanssum: Shot List Risks Selected for Analysis

Risk (code)	Final status	Residual RISMAN*	Remarks on the status of risks, after information retrieved from interviews and comments in Relatics
RI-006	Mitigated	26	-
RI-021	Materialized	-	-
RI-022	Materialized	-	-
RI-032	Materialized	-	-
RI-097	Materialized	-	This risk actually did not materialize, but was mitigated
RIS-0178	Materialized	-	-
RIS-0192	Materialized	-	-
RIS-0193	Materialized	-	-
RIS-0257	Materialized	-	This risk actually did not materialize, but was mitigated
RIS-0300	Materialized	-	-
RIS-0313	Materialized	-	-
RIS-0324	Mitigated	28	-
RIS-0331	Mitigated	25	This risk did materialize
RIS-0334	Mitigated	32	-
RIS-0425	Mitigated	25	This risk did materialize
RIS-0428	Mitigated	28	-
RIS-0433	Materialized	-	-

Notes:

The empty cells are from materialized risks, so their residual RISMAN scores are irrelevant to the selection criteria via the risk matrix.

8 Ooijen-Wanssum: Diagram Risk Causes



Notes:

Dark green = cause

Light green = risk

Grey with corners = additional activity to complete the cause-effect chain (additional info)

9 Ooijen-Wanssum: Timeline Risk Status for each Theme

Risico	Identificatie	Eindstatus	Datum identificatie	Datum opgetreden	Datum correctief (beheerst)	Datum beheerst
6	tender	beheerst	5-10-2016			11-5-2017
6	tender	beheerst	5-10-2016			11-5-2017
21	tender	opgetreden	5-10-2016	13-2-2017	29-3-2019	
22	tender	opgetreden	5-10-2016	6-2-2017	3-5-2017	
32	tender	opgetreden	5-10-2016	8-12-2018	11-2-2019	
32	tender	opgetreden	5-10-2016	8-12-2018	11-2-2019	
97	tender	beheerst	5-10-2016			7-5-2019
178	uitvoering	opgetreden	25-1-2017	26-9-2018		
178	uitvoering	opgetreden	25-1-2017	26-9-2018		
192	uitvoering	opgetreden	1-2-2017	10-3-2017	23-8-2017	
192	uitvoering	opgetreden	1-2-2017	10-3-2017	23-8-2017	
192	uitvoering	opgetreden	1-2-2017	10-3-2017	23-8-2017	
193	uitvoering	opgetreden	20-2-2017	20-2-2017	4-6-2020	
193	uitvoering	opgetreden	20-2-2017	20-2-2017	4-6-2020	
257	uitvoering	beheerst	2-10-2017			6-11-2017
257	uitvoering	beheerst	2-10-2017			6-11-2017
300	uitvoering	opgetreden	22-1-2018	25-1-2018	14-3-2018	
313	uitvoering	opgetreden	5-2-2018	1-3-2018	9-3-2018	
313	uitvoering	opgetreden	5-2-2018	1-3-2018	9-3-2018	
324	uitvoering	beheerst	7-5-2017			30-8-2018
324	uitvoering	beheerst	7-5-2017			30-8-2018
331	uitvoering	opgetreden	16-7-2018	15-1-2020	5-2-2020	
331	uitvoering	opgetreden	16-7-2018	15-1-2020	5-2-2020	
334	uitvoering	beheerst	28-8-2018		24-9-2018	
425	uitvoering	opgetreden	10-2-2020	7-4-2020	4-5-2020	
428	uitvoering	beheerst	13-2-2020			
428	uitvoering	beheerst				
433	uitvoering	opgetreden	10-4-2020	4-6-2020		
433	uitvoering	opgetreden	10-4-2020	4-6-2020		

10 Ooijen-Wanssum: Remarks for increasing RISMAN scores

Risico	VGR	Algemeen	Uit interviews
RI-021	0	onderschatting + meer inzciht door nieuwe informatie	dit risico is opgetreden met een hogere impact dan verwacht. Na gunning konden we verder onderzoeken en bleek de kwaliteit van de damwand niet in orde
RI-022	0	onderschatting (te optimistisch)	we dachten dat we de opdrachtgever wel zouden kunnen overtuigen van onze uitgangspunten voor het ontwerp dat we in de tender fase hebben gemaakt. Maar tijdens de gesprekken met OG bleek er geen beweging in te zitten. Kans van optreden nam toe waarna het risico daadwerkelijk is opgetreden.
RI-032	2	meer inzicht door nieuwe informatie, nieuwe context	in die fase is er veel aan het ontwerp gewerkt (samen met omgeving via ontwerp ateliers), en zijn we erachtergekomen dat het werk groter was dan in eerst instantie verwacht, waardoor het werk langer zou duren, dus er een grotere kans van optreden van dit risico ontstaat. Het idee was om meteen te beginnen met deze werkzaamheden, maar door de grote hoeveelheid en nieuwe inzichten moest het doorgeschoven worden naar later in de planning. Dit zou de impact van het risico ook verhogen.
RIS-0178	2	admin error	waarschijnlijk een administratief foutje. OF even een optimistisch momentje, maar die is in de daaropvolgende periode gecorrigeerd.
RIS-0331	29	meer inzicht door nieuwe informatie, nieuwe context	gesprekken met bedrijf Kersten, waarin zij aangaven dat het veel werk is om het perceel klaar te maken voor werkzaamheden (inrit verplaatsen). Daaruit is geconcludeerd dat de plannign zou uitlopen als zij hun inrit niet op tijd zouden kunnen verplaatsen. Daarnaast bleek er ook nog geen deal te zijn gemaakt voor het overkopen (taak van OG)
RIS-0331	36	urgantie/ deadline	risico werd steeds kritischer omdat we dichter bij de deadline kwamen. Daarnaast hadden we er geen vertrouwen in dat de gemaakte afspraken nagekomen zouden worden
RIS-0425	40	-	rest RISMAN was niet hoger dan initieel RISMAN bij identificatie (zoals grafiek wel suggereerd), maar was pas zichtbaar bij een hogere RISMAN score in de voortgangsrapportages. Verder is dit een risico dat later is aangemaakt en onderdeel is van een eerder genoemd container risico (hoogwater). Pas wanneer het risico zou gaan optreden, werd en container risico opgesplitst in kleinere risico's, om zo locatiespecifieke maatregelen te kunnen treffen. Door goede afspraken met omgeving en OG is het opgetreden risico correctief beheerst: het is opgetreden (mijlpaal 1 april klaar zijn is niet gehaald), maar de gevolgen zijn beheerst, omdat er instemming is met omgeving en OG.

11 Interviews

Risk manager from project N244-N246

Silvester Pastoor – Procesmanager

Risk manager from project Ooijen-Wanssum

Ruben van der Zanden – Procescoördinator 3

Risk managers present during expert session

Ralph Goed – Procescoördinator 3

Timo Wolring – Procescoördinator 2

Huub Colen – Procescoördinator 2

Cost controller at Dura Vermeer Landelijke Projecten

Joost Kuijs – Vakgroepmanager Kostendeskundigen

Dates of interviews, meetings and email conversations

18-05-2021 04-08-2021 11-08-2021 13-08-2021 25-08-2021 01-09-2021 23-09-2021* 26-10-2021* 23-11-2021 14-12-2021	Den Bosch Online Online Mail Online Online Hoofddorp Online Mail Online	Silvester Pastoor
08-09-2021 20-09-2021 25-10-2021* 26-11-2021	Rotterdam Utrecht Hoofddorp Online	Ruben van der Zanden
05-07-2021	Online	Joost
29-10-2021	Hybrid: online & Rotterdam	Ralph Goed, Time Wolring and Huub Colen

*These meetings were used to discuss the cause-effect diagrams per case study. Feedback and input from the interviewee was directly implemented into the diagram. No additional notes were taken.

Interview met Procesmanager N244-N246

Silvester Pastoor

18-05-2021 – Overleg kantoor Den Bosch

Eerste set data is doorgestuurd en geanalyseerd. Dit interview is bedoelt om het project beter te leren kennen en de eerste opvallende dingen te bespreken, om zo meer af te kunnen bakenen en sturing te geven aan het vervolg van het onderzoek.

1. Welke datum wordt genoteerd in Relatics bij invoerveld ‘datum’?
    - Invoerdatum van het risico: wanneer het in Relatics is ingevoerd.
2. Zit er een verschil in ON/OG en OG/ON risico’s?
    - Beide risico’s hebben een gedeelde verantwoordelijkheid tussen ON en OG. Bij ON/OG risico’s is er meer verantwoordelijkheid bij ON, en bij OG/ON risico’s is er primair verantwoordelijkheid bij OG, en secundair bij ON.
3. Waarom wijzigde de manier van rapporteren van risico’s tijdens het project?
    - PNH (Provincie Noord-Holland) dachten dat ze niet in control waren. We zijn in gesprek geraakt hierover en ze wilde graag dat het risicomanagement werd aangepast. Ook wilde ze dat alles (inclusief wijzigingen) in de hoofdplanning verwerkt werd. Uiteindelijk hebben we besloten de risico’s anders te rapporteren (zie voortgangsrapportages).
4. Hoe wordt restrisico (rest RISMAN) gebruikt in dit project?
    - Rest RISMAN score is de waarde van het risico wanneer alle beheersmaatregelen zijn uitgevoerd.
5. Wat is belangrijke informatie voor het managen van risico’s in dit project? Op basis waarvan heb jij vooral beslissingen gemaakt? En hoe komt het dat sommige (initiele) RISMAN scores 0 zijn? Zo kan je het toch niet monitoren/ managen/ bijhouden?
    - Er was een capaciteitsprobleem binnen projectmanagement van Dura Vermeer. Daarom is niet alles goed, en met een ‘10’ uitgevoerd.
    - Bij risicomanagement ligt de focus op grote, kritieke risico’s (met veel effect), in plaats van VEEL risico’s.
    - Geld of Tijd is de allerbelangrijkste factor in de consequenties van een risico (ipv de totale RISMAN som). Uitloop van een project is namelijk geen optie. Het kost je makkelijk 10k per dag.
6. Wat is het verschil tussen een VTW en een WOG?
    - VTW = verzoek tot wijziging, afkomstig vanuit de ON
    - WOG = wijziging opdrachtgever, afkomstig vanuit de OG
    - Door hier een duidelijk onderscheid in te maken was het ook duidelijk wie ervoor zou moeten betalen en wie de verantwoordelijkheid had. Deze aanpak was erg successvol
7. Wat is een RBP?
    - Risicobeheersplan
8. Waar staat BLVC voor?
    - Bereikbaarheid, leefbaarheid, veiligheid en communicatie

Interview met Procesmanager N244-N246

Silvester Pastoor

04-08-2021 – online via MS Teams

*In grijs antwoorden van Silvester

1. Algemene vragen over het project

1.1. Is er een globale planning beschikbaar met data van projectfasen en mijlpalen?

- Ja die is beschikbaar. Wat heb je nodig?
- Voor analyse is het prettig om de totale hoofdplanning te hebben.
- De laatste hoofdplanning wordt toegestuurd.
- De planning wordt dus integraal gebruikt door de hele tijdlijn van het project?
- Planning: begint op een hoog niveau (hoog over), en die grove brokken worden steeds verder uitgewerkt met meer details. De planning moet integraal benadert en gebruikt worden, anders loop je gigantisch uit de kosten en daarmee tijd.

1.2. Wat zijn alle blokken in het bow-tie diagram van de tenderfase (risico 1 en 2)? Ze zijn niet gehighlight en ook niet met een lijn verbonden in een oorzaak-risico-gevolg relatie.

- Dit is de verzamelpagina, daarna zijn ze uitwerkt in het risicobeheersplan.
- En er zijn veel meer risico's benoemd dan in het uiteindelijke risicobeheersplan. Hoe komt dat?
- Er waren zoveel risico's, dat er uiteindelijk gekozen is om sommige niet in het risicobeheersplan op te nemen of uit te werken. Daarom staan er maar een paar risico's in het definitieve document. Degene die hierin benoemd zijn, hebben de grootste impact.

1.3. Wat is een Task Force? Het wordt een aantal keer benoemd in de voortgangsrapportages en risicio's, maar verder niet toegelicht.

- In het kort: Task Force is een team opgesteld met mensen van OG en ON, die samen bepaalde afspraken maken over werk met veel raakvlakken en afhankelijkheden, zodat het projectteam zich kon focussen op de huidige fases en het werk dus door kon gaan.
- Aanleiding Task Force: Er zaten zoveel fouten in het ontwerp en randvoorwaarden van de provincie (vb systeemgrens (grond) was kleiner dan waar op gebouwd moest worden, en er moesten een aantal lichtmasten vervangen, maar die stonden er niet eens). Daarnaast was er ook een grote afhankelijkheid met een ander project (ten noorden van Kogerpolderbrug). Er mocht niet geasfalteerd worden voordat de Leeghwaterbrug (in Alkmaar) klaar was. Dat andere project liep 2 jaar achter op schema, wat voor problemen zorgde in de planning en haalbaarheid van dit project. Deze fouten en afhankelijkheden zouden in de Task Force besproken worden en opgelost, door keuzes te maken hoe af te wijken van het contract, om de fouten op te lossen, en afspraken te maken wanneer bepaalde werkzaamheden uitgevoerd mochten worden, rekening houdend met de raakvlakken van het andere project.

Interview met Procesmanager N244-N246

Silvester Pastoor

04-08-2021 – online via MS Teams

- Voorbeeld belangrijke keuze door Task Force:
    - vanuit het contract was er als tijdelijk beweegbare brug ingecalculeerd met één strook voor voetgangers en een om-en-om regeling voor het auto- en vrachtverkeer. Deze situatie is met de verkeersmodellen van Dura Vermeer doorgerekend en bleek niet realistisch te zijn. Het verkeer zou volledig vastlopen op regionale schaal.
    - Dura Vermeer concludeerde dat er een tijdelijke beweegbare brug moest worden gebouwd met dezelfde capaciteit als de originele brug. Om tijd en geld te besparen wilden we de tijdelijke brug 'oppakken' en hergebruiken bij de Kogerpolderbrug. Maar door de vele wijzigingen kon dit in tijd niet meer serieel in tijd lopen. Daarom moesten er 2 bruggen tegelijk gebouwd worden. Hierdoor hebben we een extra tijdelijke vaste brug gebouwd bij de Kogerpolderbrug
    - Dit probleem is behandeld door de Task Force, welke keuzes hebben gemaakt over de planning, budget, afprijzing en meer. Dit is voordelig om paralel aan het project te behandelen in een aparte Task Force, omdat het projectteam dan verder kan werken aan dagelijkse taken, en niet te veel uitloopt met de werkzaamheden, omdat dit probleem nog niet opgelost was. Door verschillende disciplines (van OG en ON) over de diverse casussen na te laten denken krijg je een gedragen en afgestemde oplossing.

2. Algemene vragen budget (excel)

Voor informatie over het budget en de bewakingsposten kan je het beste bij Bart Spierings (projectcontroller) zijn. Hij was de projectcontroller voor dit project. Ik werkte veel met hem samen en hij kan je meer vertellen over het budget en hoe dat is gegaan.

2.1. Waar staan de volgende afkortingen voor:

2.1.1.UTA (regel 12 en 13)

- alle personeelskosten (behalve bouwplaatspersoneel)

2.1.2.PSU en PFU (regel 19)

- PSU = project start up (in het begin)
- PFU = project follow up (elk half jaar)
    - kosten hiervan worden 50-50 met OG betaald, op basis van een stelpost vanuit het contract a €10.000

2.1.3.ABK (regel 114-118)

- algemene bouwplaatskosten

2.1.4.Is WYZ hetzelfde als WIJZ?

- dat is hetzelfde

Interview met Procesmanager N244-N246

Silvester Pastoor

04-08-2021 – online via MS Teams

2.2. Waarom zou je goedgekeurd meerwerk niet uitgeven? Enkele voorbeelden: Hekwerk familie Koster (regel 126), WIJZ-0147 (regel 134), Kans 3 (regel 145), Kans TF (regel 146).

- Deze kosten zijn 1 op 1 toegevoegd vanuit een wijziging
- Het kan zijn dat het in q4 nog niet uitgegeven is
- Maar je kan het beste Bart Spierings vragen hoe het met deze bewakingsposten zit

3. Algemene vragen risico's

Er zijn risico's geanalyseerd in de kwartaalrapportages, tenderdocumenten en Relatics. Hieronder zijn een aantal opvallende dingen genoteerd. Graag bespreek ik deze onderwerpen om een completer beeld te krijgen van het risicomanagement op dit project.

3.1. Compleetheid van het risicodossier

3.1.1. In Q1 2018 zijn er geen RISMAN waardes ingevuld voor de risico's, maar er is wel een top 20 gemaakt. Veel risico's hiervan worden later niet meer genoemd in risico updates. Waarom zijn deze risico's niet beoordeeld, en waren ze toch niet zo cruciaal?

- Kwartaalrapportage schrijf je voor je stuurgroep. Het boeit hun niet welke RISMAN scores aan je risico's hangen. Het is belangrijk WELKE risico's het zijn, en wat het financiële effect is. De benoemde risico's zijn dus wel belangrijke risico's.
- Risico's uit Q1 zijn de risico's uit de tender: "Je moet eerst een auto bouwen voordat je kunt sturen". In Q1 ben je nog veel bezig met inrichting van het project en heb je nog geen tijd voor risicobeheersing en inventarisatie van nieuwe risico's.

3.1.2. In Relatics bij de tab 'controle' in Relatics zijn er: 42 risico's zonder beheersmaatregel en 28 risico's zonder consequenties (rest RISMAN)

- Waarom zijn deze gegevens niet ingevuld van zoveel risico's? Is dit niet belangrijke stuurinformatie?
- Je zou het moeten invullen en gebruiken, maar "ik ben er best wel slordig in". Was toentertijd met van alles druk en liet risicomanagement een 6'je zijn.
- Grote kans dat het allemaal vervallen risico's zijn en/of foutjes bij het invullen. Ik heb de risico's niet verwijderd uit Relatics.

3.1.3. Nu in de huidige staat van Relatics zijn bijna alle risico's vervallen. Dit maakt het lastig en vooral enorm veel werk om te traceren of ze nooit zijn

ingevuld, of dat de beheersmaatregelen en consequenties zijn verwijderd, omdat ze zijn vervallen. Wat is de reden voor het ontbrekn van beheersmaatregelen of consequenties? Wat kan er aangenomen worden voor het onderzoek?

- Er zullen beheersmaatregelen aan hebben gehangen, maar die zullen waarschijnlijk verwijderd zijn.

3.1.4. In Relatics kan je sorteren op initieel en rest RISMAN score. Er zijn 98+ risico's met initieel RISMAN = 0, rest RISMAN=0, geen GOTKV ingevuld (risicoregister gaat niet verder dan 98 entries per pagina, en kan niet naar de volgende pagina). Waarom zijn deze gegevens niet ingevuld van zoveel risico's? Is dit niet belangrijke stuurinformatie?

- Ik weet niet zo goed wat daar gebeurd is, want we hebben het altijd ingevuld. Soms is er een beheersmaatregel gekoppeld, dus dan zou het ook ingevuld moeten worden.
- Als het restrisico 0 is, en het initieel risico wel een score heeft. Dan is door de beheersmaatregel het risico afgenomen naar 0. En is er dus geen risico meer. Je hebt dus het risico volledig gemitigeerd.

3.1.5. Kan je toelichting geven op het omzetten van tender risico's naar het risicodossier in Relatics of de voortgangsrapportage? Ik zie namelijk weinig overeenkomsten in codering of naamgeving in deze fases.

- Het is op ervaring gedaan. In de tenderfase was de risicomanager meer ervaren dan Silvester, waardoor de oorzaak - risico - gevolg naamgeving in de tenderfase veel beter/ consequenter is gedaan. Met de huidige ervaring zou ik het nu ook anders/ beter doen.
- De codes van de risico's zijn inderdaad niet gelijk
- Alle beheersmaatregelen (vanuit de tender) zijn als EMVI eis meegenomen in Relatics en daarmee geborgd in het V&V-proces Bij het vertalen van tender risico's naar uitvoeringsfase is dit praktisch om te gebruiken

3.1.6. Waarom is er een switch gemaakt in de manier van rapporteren van risico's? Was de data in het begin van het project niet beschikbaar? Is Relatics pas later in gebruik genomen?

- De risicomanager van de opdrachtgever had een onprettige manier van communiceren: heel erg de 'wij vs jullie' mentaliteit: 'samenwerken was doodeng'
- Op een gegeven moment is die weggegaan en kregen we een nieuwe risicomanager. De samenwerking verbeterde en we deden nu ook gezamenlijke risicosessies.
- Wij krijgen ook meer capaciteit om risicomanagement beter in te vullen

Interview met Procesmanager N244-N246

Silvester Pastoor

04-08-2021 – online via MS Teams

3.2. Ben jij procesmanager ook geweest tijdens de tenderfase? Hoe gebeurt die overdracht normaal? Hoe wordt het voorbereidt en hoe effectief is dat?

- Nee, dat was ik niet maar Bertine Korevaar die in de tenderfase was betrokken bij dit project en de risico's heeft geïnventariseerd en geanalyseerd. Je kan haar alles vragen over de tenderfase en risicomanagement in die fase van het project. Er is geen overdracht geweest tussen Bertine en mijzelf.

3.3. Financiële risico's worden apart behandeld in de kwartaalrapportages, waarom? Soms is er ook overlap? Wie is verantwoordelijk voor deze risico's? 'Normale' risico's hebben toch ook een financiële impact?

- Het risicobudget is een potje dat je meeneemt in je totale budget om te reserveren voor te treffen maatregelen of extra kosten door opgetreden risico's. Tijdens het project zal je dit stukje van het budget dus uitgeven aan risico's
- Een deel van de impact van een risico is ook geld.
- Het zou kunnen dat een tweestrijd heeft plaatsgevonden, omdat er zoveel wijzigingen hebben plaatsgevonden. Daarom kan het risicobudget niet altijd meer overeenkomen.
- Het risicobudget fluxueert tijdens het project. Je vangt sommige minnetjes op met je risicobudget en geeft geld uit aan beheersmaatregelen. Je verdeelt dat budget dan naar andere posten. Bij het overeenkomen van Wijzigingen boek je ook budget naar je risicobudget. Hier ga je vervolgens weer mee aan de slag. Door de grote hoeveelheid Wijzigingen hebben we ook vaak wat budget achtergehouden die we gestaffeld vrij hebben laten vallen t.b.v. Project Einde Werk (PEW) resultaat.

4. Kritieke risico's

Alle risico's analyseren gaat niet lukken, dus er zal een selectie worden gemaakt. De risico's worden uitgezet in tijd, en de oorzaak-gevold relaties worden per risico en onderling in kaart gebracht.

- Voortgangsrapportages (29 stuks) worden elke 4 weken geschreven voor de OG: het is aan te raden deze te analyseren voor meer inzicht in kritieke risico's. Deze kunnen gedeeld worden.

5.1. Er zijn verschillende lijsten met risico's gemaakt in de voortgangsrapportages (top 5 nieuw, top 5 stijgend, etc). Zouden kritieke risico's hierin te vinden zijn, of zijn er nog andere indicatoren voor een kritiek risico? Bijvoorbeeld, initieel RISMAN score >20, rest RISMAN score >15, initieel/ rest kans van optreden >4, rest kans van optreden >4, initieel/ rest Geld >4, initieel/ rest Tijd >4.

- Dit zijn zeker interessante filters, maar het is veel interessanter om te kijken (in het perspectief van risicomanagement), naar de vermindering van RISMAN score over tijd of door het treffen van een bepaald risico. De verandering van

scores is belangrijker dan of het een bepaalde score heeft. Of juist het niet veranderen van de score, ondanks dat er maatregelen zijn getroffen.

- De OG kijkt alleen maar naar restrisico. Zij zien dit meer als ‘initieel risico’. Maar voor risicomanagement is initieel risico belangrijk. Bij een evaluatie kijken we daarentegen weer naar restrisico.
- De voortgangsrapportages zullen veel inzicht geven in de kritieke risico’s.

Interview met Procesmanager N244-N246

Silvester Pastoor

11-08-2021 – online via MS Teams

1. Voortgangsrapportages
   1.1. Zijn de bijlagen met top 10 risico's ook beschikbaar? Die zaten niet in de VGR. Het betreft rapportage 4 t/m 13.
      - Deze zijn beschikbaar en worden verstuurd

   1.2. Zijn afwijkingen ook belangrijk? Of kan ik me beter focussen op risico's (en wijzigingen)? Hoe verhouden deze drie concepten zich tot elkaar en wat wordt waarvoor gebruikt?
      1.2.1. Wijzigingen
         - Formele manier om aan te geven dat er iets in het contract niet klopt of haalbaar is. Door een wijziging in te dienen vraag je de OG of hij dit oké vindt, en in sommige gevallen hangt hier ook een financiële consequentie aan.
         - Op dit project zijn wijzigingen voor gebruikt om meer- en minderwerk te verwerken en vast te leggen. De OG wilde meer dan dat er in het contract stond, dit is vaak met afspraken via een wijziging tot meerwerk geregeld. Er was een grote spanning aanwezig rondom het M/M werk.
      1.2.2. Afwijkingen
         - Afwijkingen worden vaak gebruikt om kleinere, minder formele zaken vast te leggen. Hierbij kan je denken aan een spelfout in het contract. Met een afwijking vraag je toestemming aan de OG om deze kleine fouten te corrigeren, zodat de eisen weer haalbaar zijn.
            - vb OG schreef in het contract dat ze EMA asfalt wilde hebben. Dit is een spelfout en moet EME asfalt zijn. (EMA bestaat niet)
            - vb kleur grijs (RAL code) van OG staat in het contract. Maar door omstandigheden (zoals beschikbaarheid van de kleur in de markt) is het een andere kleur grijs geworden. Als de OG dit accepteert is het een wijziging, en dan is die geldig ter vervanging van de benoemde kleur in het contract.
         - Afwijkingen kunnen ook gebruikt worden voor intern akkoord bij een afgeleide eis. Vanuit de eisen van de OG worden specifieke eisen afgeleid, vaak inclusief toleranties. Wanneer er niet meer aan die specifieke eis voldaan wordt, kan er opnieuw bekeken worden of het resultaat nog steeds voldoet aan de initiële eis van OG. Wanneer dit het geval is, kan dit met een afwijking goedgekeurd worden.
            - vb plaatsing van funderingspaal heeft een tolerantie van plus en min 10 cm. Een enkele paal die afwijkt is over het algemeen geen probleem, maar als elke

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Silvester Pastoor

11-08-2021 – online via MS Teams

funderingspaal verkeerd staat moet je wel een contoleren of het ontwerp nog voldoet. Stel, de paal staatnu 11 cm naast de initiële plaats (meer dan 10 cm afwijking). Dan moet er gerekend worden of met deze 11 cm afwijking het ontwerp nog steeds voldoet.

- Afwijkingen worden gebruikt om het gesprek aan te gaan met de OG over een kleine verandering ten opzichte van het contract. Dan hoef je geen wijziging over één te komen
- Een alternatief voor een signalering van de 'afwijking' is een 'issue'
- Als OG de afwijking niet accepteert: dan kan dit een risico worden…
- Advies voor analyse: filter op proces, ipv product afwijkingen en scan inhoudelijk. Dit kan interessant zijn en inzicht geven in het verloop van het project. We hebben bijvoorbeeld veel afwijkingen gehad dat OG te laat was met reageren op acceptatietermijnen van Documenten. Dit heb ik meerdere malen aangegeven in het VGO en in de verschillende versies van het CSO / Documentenplanning.

1.3. Waarom vervallen bepaalde risico's, ook al hebben ze nog een hoge RISMAN score? Afronden mijlpaal? Of andere mogelijke reden?

- Als je in je standaardwerk (vb doorvaartbreedte van een sluis) met het risico rekening kan houden (evt met het treffen van beheersmaatregelen), dan kan het risico vervallen.
- Als je alle randvoorwaarden goed hebt staan (genoeg geld, tijd, materiaal etc). Dan kan het risico acceptabel worden (lage kans, maar lage effecten), en zou je het kunnen laten optreden. Bijvoorbeeld uitloop in planning door een archeologisch vonst, wanneer je tijd genoeg hebt, om op andere locaties aan de slag kan.
- Wanneer de situatie goed uit te leggen is aan OG: dat het risico is opgetreden ondanks de maatregelen die je hebt genomen, de afweging hebt gemaakt in gebruik van resources (niet te veel geld, tijd of materiaal investeren in een risico dat toch een enorm lage kans heeft van optreden), dan zal een OG het ook begrijpen en accepteren. Uiteraard heb je dan wel te maken met "schade" en dat moet je met OG proberen op te lossen.

2. Relatics

2.1. Hoe kan ik de 'browse' history functie toepassen op 'kans van optreden' risico's in Relatics?

- Dit kan niet in Relatics. Mogelijk aan Joost Gosman vragen.
- 'Kans' wordt niet vaak aangepast, dus je kan in de meeste gevallen ervan uitgaan dat deze waarde gelijk blijft gedurende het hele project.

Interview met Procesmanager N244-N246

Silvester Pastoor

11-08-2021 – online via MS Teams

2.2. Veel beheersmaatregelen hebben status 2 (inhoudelijk akkoord), maar het is niet bekend of dit uitgevoerd is. Sommige beheersmaatregelen zijn wat vaag omschreven (vb RIS-0063 “veel aandacht voor onderhoud en reparatie”) of hebben een lange doorlooptijd (vb RIS-0176 “Samen met OG optrekken en problemen samen oplossen”)

- Bijna alle beheersmaatregelen worden uitgevoerd door werkvoorbereiding. Je kan ervan uitgaan dat ze zijn uitgevoerd. De ‘geplande datum uitgevoerd’ kan aangehouden worden als datum van uitvoering voor de analyse.
- In principe zijn alle beheersmaatregelen (ongeacht de status) uitgevoerd
- Over het algemeen trekken we geen beheersmaatregelen naar ons toe die veel geld kosten (of we laten OG hiervoor betalen middels een Wijziging. Bijvoorbeeld wijz-0088)
- In geval van vaag omschreven beheersmaatregelen:
    - dan vertrouw je erop dat ze die goed uitvoeren: je werkt samen in een team, dus je moet niet iedereen willen controleren. Ieder heeft zijn eigen expertise, dus weet hoe die de beheersmaatregelen moet oppakken en uitvoeren.
- In geval van lange doorlooptijd:
    - de afspraken of uitwerking staat vaak in de verslagen/ notulen van de VGR meetings. Erg veel werk om dit ook nog te analyseren.

3. Zoom in op RIS-0063

3.1. Update initieel risico vs restrisico. Hoe werkt het?

- Eerst inschatting initieel risico (de 0-meting);
- Dan beheersmaatregelen;
- En dan rest risico (meegenomen dat je beheersmaatregelen uitgevoerd zijn).
- Vervolgens wordt tijdens het project in principe alleen het restrisico aangepast. Hierin zie je het resultaat van de poging tot mitigeren van het risico. Tegenwoordig is er een ‘actueel risico score’ die dit weergeeft. Maar in dit project wordt dit gereflecteerd in het restrisico.
- Soms komt het voor (vb wanneer er nieuwe project- en of procesmanagers zijn) dat er een nieuwe iteratie is in het initiële risico. De komst van de nieuwe risicomanager van de OG is hier een voorbeeld van op dit project.

Interview met Procesmanager N244-N246

Silvester Pastoor

13-08-2021 – mailcontact

Wat betreft de selectie van de risico's, heb ik nog iets meer info nodig voordat ik je een short list kan sturen. De huidige short list bevat nog steeds 60 risico's. De voortgangsrapportages zijn wel erg inzichtelijk en helpen enorm. Hieronder mijn vragen op een rijtje. De laatste vraag is nu het belangrijkste, de andere 2 zijn prettig voor het filteren. In de bijlage ook het overzicht van de risico analyse tot nu toe (blad 1 is de 1e vertaalslag vanuit de VGR, blad 2 is de huidige shortlist met 60 risico's, waarvan de vetgedrukte (ongv 18 stuks) naar mijn mening de grootste potentie hebben voor verdere analyse met de huidige inzichten).

1. Vanaf welke RISMAN waarde zou jij extra aandacht geven aan het risico, in de zin dat het wel degelijk een groot risico is?
   1.1. Baseer je dit op de totale RISMAN score, vb >25?
      - Ik zou pas actief gaan sturen op een initieel risico wanneer deze hoger is dan een score van 50-60 of als het een exotisch risico is die niet in het normale proces meegenomen kan worden. Bijvoorbeeld, we moeten met overvliegende vliegtuigen rekening houden.
   1.2. Is de kans van optreden hierin dominant, vb K>3 of K>4?
      - Kans is voor mij van onderschikt belang, ik kijk meer naar tijd en geld.
   1.3. Is een consequentie zoals tijd en geld hierin dominant, vb T>4 of G>4?
      - Tijd eerst, dan geld, dan kans, dan veiligheid, en dan de rest.

2. Vanaf welke RISMAN waarde zou je 'normaliter' een risico accepteren/ laten vervallen? Deze RISMAN wordt bepaald door 1 kans en 6 consequenties (geld, imago, tijd, etc).
   - Bij lage impact op tijd en geld. "Sorry zeggen is soms ook al een prima beheersmaatregel".

3. Als een risico vervalt en benoemd wordt in de VGR dan staat er vaak bij 'vervallen, huidige RISMAN waarde …'. Nu heb ik voor een aantal risico's de waardes teruggezocht in Relatics. Daaruit blijkt dat de benoemde 'huidige waarde' uit de VGR de initiële waarde is in Relatics, en niet de restrisico waarde. Waarom zou dit op deze manier gerapporteerd worden?
   - Soms wil je je OG motiveren om ook te acteren, dan kun je het best initieel gebruiken om meer impact te maken.

4. Welke informatie wil je communiceren met de initiele waarde? Het is voor mij verwarrend omdat in de rest van de RISMAN scores in de VGR wel de restrisico RISMAN wordt gerapporteerd. En ik heb aangenomen dat restrisico RISMAN de actuele RISMAN score is. Of is er een verschil tussen huidig en actueel wat ik nu over het hoofd zie? (vb risico 13 en 21)
   - Laten we hier volgende week even op verder in gaan. Heb samen met de CM, TM en PM vaak een strategisch keuze gemaakt om een risico te gebruiken om OG te stimuleren tot actie.

Interview met Procesmanager N244-N246

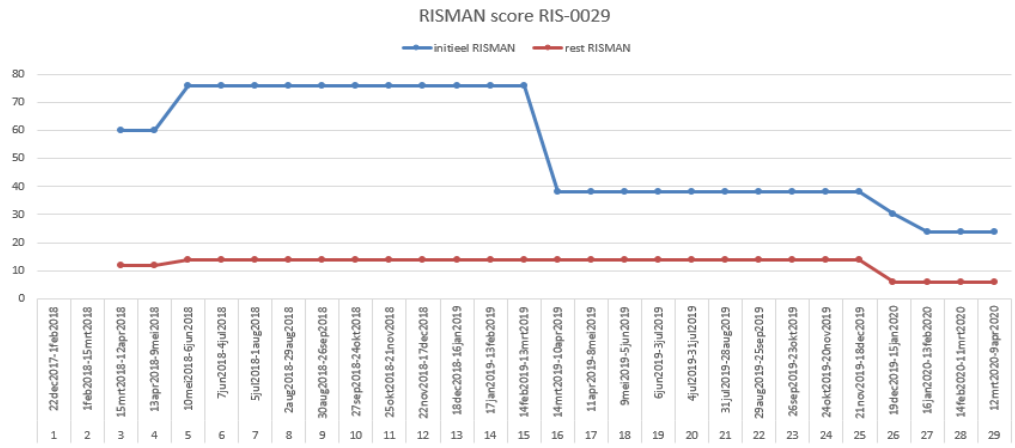
Silvester Pastoor

25-08-2021 – online via MS Teams

1. Risico's

1.1. RIS-0029

RBP1: Tijdens de uitvoering van het project worden Bereikbaarheid (B), Leefbaarheid (L), Veiligheid (V) en Communicatie (C) als gevolg van het project onvoldoende beheerst



1.1.1. Toelichting op het risico

- Dit is een risico uit de tenderfase en is opgenomen in het ingediende risicobeheersplan

1.1.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico (P3, 5, 16, 25, 26 en 27)?

- In P3 is het risicodossier pas volledig en goed overgenomen om tijdens de voortgangsrapportages verslag te kunnen doen over actuele en grote risico's.
- Toename RISMAN in P5 is als gevolg van een nog niet ingevulde consequentie van het risico, waardoor het lijkt op een toename, maar het eigenlijk achterstallige administratie was.
- Verder verloopt het risico volgens de verwachte curve (afname naarmate het project loopt en werkpakketten worden afgerond). Als de hoeveelheid openstaand werk afneemt dan neemt dit risico ook af, aangezien men minder last gaat krijgen van de werkzaamheden.,

1.1.3. Reflectie op het risico

- Initieel risico wordt meer als 'actueel risico' gebruikt dan rest risico. Dit komt met name omdat hierin wordt meegenomen dat steeds meer mijlpalen worden behaald en werkpakketten worden afgerond gedurende het project. Het is dus niet helemaal correct om hier initieel voor te gebruiken, maar ook niet helemaal onlogisch. In de nieuwe versie van Relatics is de actuele risicoscore wel opgenomen als onderdeel en kun je nu dus beter sturen op initieel – actueel -rest scores.

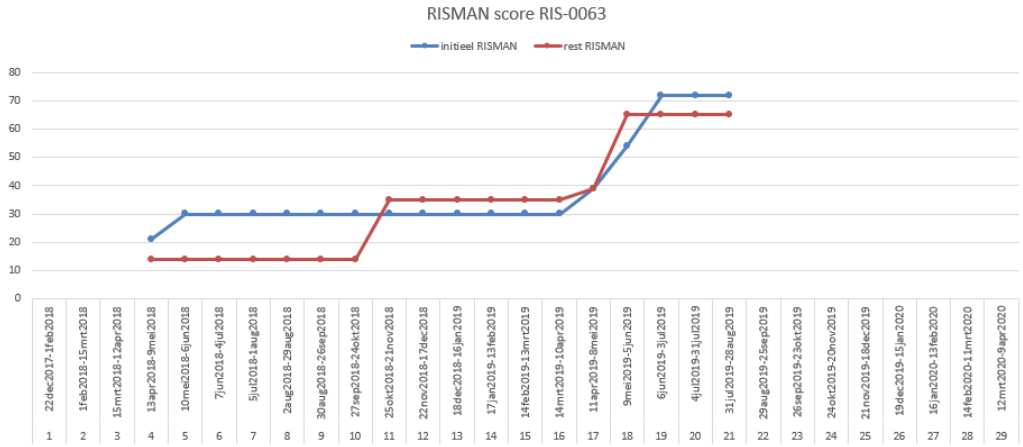
Interview met Procesmanager N244-N246

Silvester Pastoor

25-08-2021 – online via MS Teams

1.2. RIS-0063

Gezien de beperkte ontwerptijd is het niet mogelijk de beschikbaarheid van de brug middels een beschikbaarheidsberekening aan te tonen en zal de niet-beschikbaarheid tijdens de exploitatiefase blijken.



1.2.1. Reflectie op het risico

- Dit risico vertoont een hele ongebruikelijke trend: toename van risico en op sommige momenten een hoger restrisico dan initieel risico. Waarschijnlijk is er hier iets fout gegaan in de administratie van dit risico. Verder is dit risico ook enorm complex om exact uit te gaan zoeken. Om die reden wordt geadviseerd niet verder te gaan met de analyse van dit risico.
- Het risico is wel besproken met Silvester, dus dat zal hieronder nog worden toegelicht.

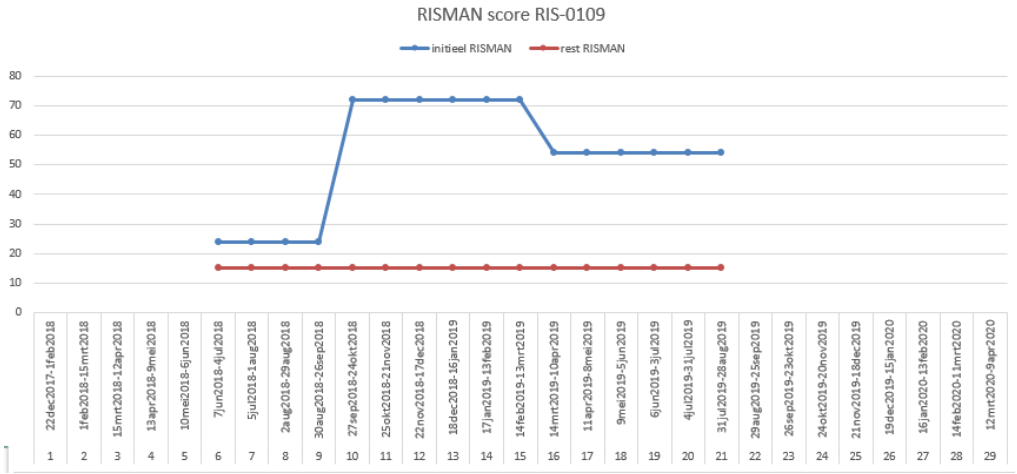
1.2.2. Toelichting op het risico

- OG had geen geld om het project conform tenderplanning te starten, dus het project is een half jaar later pas definitief gegund
- Met een RAMS analyse bepaal je uit welke componenten een brug moet bestaan. Voor de tijdelijk beweegbare brug was geen tijd in het ontwerp om deze analyse te doen. Tevens was dit de eerste tijdelijke beweegbare brug voor autoverkeer in Nederland, dus was er geen referentiemateriaal.
- De oude burg MOEST zo snel mogelijk vervangen worden door een tijdelijke brug, omdat de technische levensduur al jaren verstreken wsa . Daarom was er nog meer tijdsdruk op het ontwerp en uitvoering van deze tijdelijke brug.
- Met een RAMS analyse kan de hoeveelheid ‘down tijd’ (brug buiten gebruik) worden berekend en geoptimaliseerd. Hier was dus geen tijd voor in de beperkte periode
- De fluctuatie in de RISMAN score is een combinatie van nut en noodzaak: motivatie voor de OG en daadwerkelijk hoog risico
- In augustus 2018 is de 1e tijdelijke brug gerealiseerd. (geen wijzigingen in RISMAN score)

- In augustus 2019 is de 2e tijdelijke brug in gebruik genomen. Er is dan een enorme toename in RISMAN score. Dit kan beredeneerd zijn vanuit het perspectief dat ‘stel dat de OG gaat klagen over de brug of het ontwerp’, dan kan er niets meer aan veranderd worden en heeft het grote consequenties voor het project.
    - hieruit zou je kunnen concluderen dat de ON niet zeker is van de gemaakte keuzes in het ontwerp en de uitvoering in relatie tot het contract

1.3. RIS-0109

Prinses Amaliabrug kan niet tijdig gekoppeld worden aan de Centrale Bediening



1.3.1. Toelichting op het risico

- Dit risico gaat om het tijdig aansluiting op de Centrale Bediening in Heerhugowaard. OG was verantwoordelijk om een glasvezel ringleiding op tijd bij de bouwlocatie te krijgen, zodat de brug aangesloten kon worden op de Centrale Bediening.
- OG had eerst in het contract staan dat de brug tot maximaal 6 maand lokaal bediend kon/moest worden, maar wilde eigenlijk meteen de brug aangesloten hebben op de Centrale Bediening. Er moest ook rekening gehouden worden dat er een keet/hokje geplaatst moet worden waar de brugbedienaar gehuisvest moest worden. Dit kon volgens de vergunning dan weer niet.

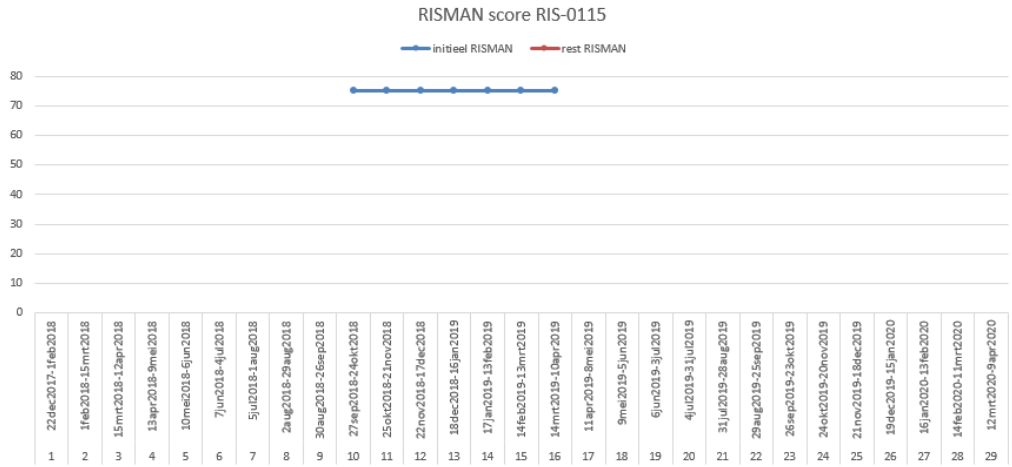
1.3.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico (P6, 10, 16, 21)?

- P6 risico is gezien, maar nog niet dringend.
- P10 flinke verhoging van het risico, omdat de ON erachter kwam dat de glasvezel ringleiding er nog niet lag
- P16 een gedeeltelijke verlaging van het risico (alleen kans van optreden daalt), omdat de 1e brug in uitvoering was maar de 2e brug nog niet. Er

kon pas op het laatste moment gecontroleerd worden of de aansluiting daadwerkelijk functioneel geplaatst is.
- P21 risico vervallen, omdat er toen getest kon worden (BM-0131) en de 1e brug volledig af was.

1.4. RIS-0115

Duikerdiameter wijziging van rond 600 naar rond 800 niet tijdig bekend voor afronden UO fase werkpakket Prinses Amaliabrug.



1.4.1. Toelichting op het risico

- Duiker = (buis)verbindingtussen 2 waterlichamen
- Volgens referentieontwerp van OG zou deze duiker rond 600 moeten zijn, maar volgens het ontwerp van ON bleek dat er meer water afgevoerd moest worden en 600 niet voldoende is .OG moet keuze maken/ knoop doorhakken om duikerdiameter 800 aan te nemen, want dit valt dan onder een scopewijziging. OG is verantwoordelijk voor juistheid en compleetheid van alle informatie, en in dit specifieke geval voor het Referentie Ontwerp.
- Uitstellen van dit besluit leidt tot mogelijk vertraging in ontwerp-, bestel- en productieproces van de duiker, vertraging van de werkzaamheden en extra kosten.

1.4.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico (P10 en 16)?

- P10: status risico = 4 opgetreden. Risico heeft deze status omdat de organisatie schade heeft ondervonden aan dit risico (keuze moet nu gemaakt worden, maar is nog niet gemaakt), maar de effecten (m.b.t. tijd en geld) zijn nog niet opgetreden.
- Het is een enorm groot risico, met flinke consequenties. Daarnaast moet de OG hier ook actie in ondernemen, en kan de ON geen maatregelen treffen.
- Daarnaast is er ook een ‘spel’, waarbij de OG gemotiveerd moet worden om actie te ondernemen, en dit wordt geremd wanneer het risico te laag

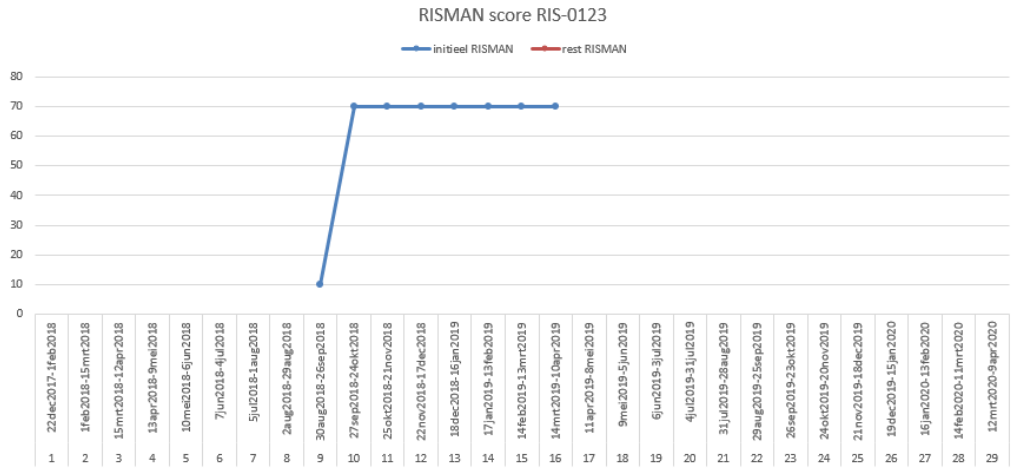
wordt aangekaart of ON veel beheersmaatregelen treft. ON heeft in dit geval wel enkele beheersmaatregelen getroffen, maar dit niet genoteerd om die reden. ON heeft onderaannemer gemotiveerd om alvast te beginnen met productie en extra mensen voor productie te mobiliseren (omdat er straks ineens heel snel geproduceerd moet worden).
    - "Dit verdient absoluut niet de schoonheidsprijs", maar dit is het speelveld van ON-OG, waarbij de afweging gemaakt moet worden of je "gaat lopen piepen" of kiest voor de "goede relatie".
    - Dura Vermeer, maar ook Silvester persoonlijk kiezen bij voorkeur altijd voor de relatie ON-OG. Dit kan soms in je nadeel (financieel) werken, maar vaak ook in je voordeel (relatie).
- Op een gegeven moment is ON maar uitgegaan van een bepaalde waarde, omdat OG nog geen bevestiging had gegeven/ keuze had gemaakt voor de 800 diameter. Dit is erg risicovol, maar op een gegeven moment moet je ook voldoen aan je resultaatverplichting.
- P16 zijn de werkzaamheden uitgevoerd

1.4.3. Reflectie op het risico

- Contractueel is dit risico best spannend (buiten de scope)
- Zie hierboven: spel en relatie ON-OG

1.5. RIS-0123

Waterhuishoudingsplan (ID3020) niet juist waardoor extra doorlooptijd benodigd is om het UO tijdig gereed te hebben



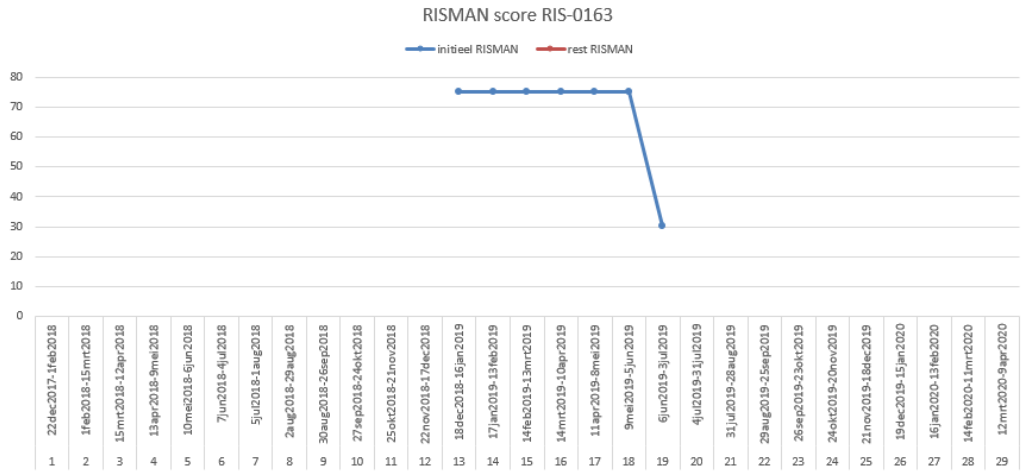
1.5.1. Toelichting op het risico

- Dit risico gaat hand in hand met RIS-0115. Dit risico is iets ruimer, gaat specifiek in op het plan dat OG moet aanleveren, en RIS-0115 is een concreet object als gevolg van het plan dat in RIS-0123 moet worden aangescherpt. Het feit dat het als 2 risico's wordt bekeken is omdat er gestuurd kan worden op specifieke producten of plannen, en er bij 2

risico's meer urgentie en actie wordt verwacht vanuit de OG dan wanneer het in 1 risico samengevoegd zou worden.

- De oorzaken en gevolgen zijn redelijk vergelijkbaar met RIS-0115, dus daar staan de meest belangrijke punten al in vernoemd. Dit risico wordt daarom nu niet verder besproken.

1.6. RIS-0163
Stopzetten uitvoeringswerkzaamheden Kogerpolderbrug



1.6.1. Toelichting op het risico

- Door de in eerdere interviews benoemde Taskforce zijn sommige werkzaamheden verschoven. De uitvoeringswerkzaamheden van de Kogerpolderbrug zijn later in de tijd gepland. Hierdoor zullen deze plaatsvinden in het broedseizoen van weidevogels. Daarom is het een risico dat de werkzaamheden mogelijk moeten worden stopgezet, wanneer er een vogel aan het broeden is.
- De maatregelen in dit risico zijn preventieve beheersmaatregelen om te voorkomen dat vogels deze locatie kiezen om hun nest te bouwen. vb inpakken van de brug, lopen met een hond, vliegen met een roofvogel, grasland maaien, oevers kaal houden etc. Hierdoor wordt het onaantrekkelijk voor vogels om er te gaan broeden, en zullen de werkzaamheden broedende vogels niet verstoren.

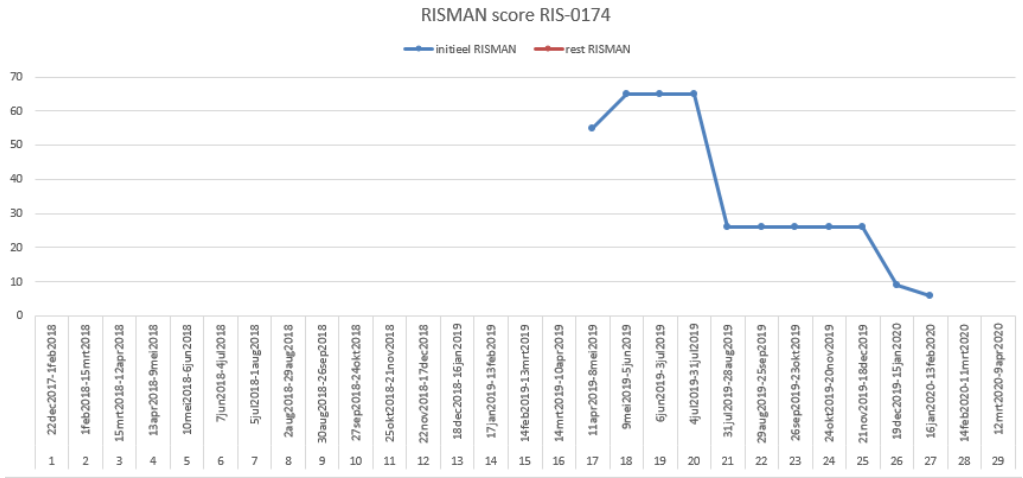
Interview met Procesmanager N244-N246

Silvester Pastoor

25-08-2021 – online via MS Teams

1.7. RIS-0174

Verantwoordelijkheden PNH omtrent omgevingsmanagement worden niet tijdig uitgevoerd.



1.7.1. Introductie/ toelichting op het risico. Hoe is de relatie met de OG, en hoe ga je om met dit risico?

- Deze nieuwe omgevingsmanager van de OG gaf aan “Ik ga het overdrachtsdocument niet lezen”. Dit was aanleiding voor ON om dit risico te benoemen. Daarnaast werd er niet tijdig reactie gegeven op bepaalde vraagstukken, werden brieven weken te laat verstuurd, waardoor de kans op klachten zwaar toenam.
- Door het risico te noemen val je de OG wel aan. Het is dus belangrijk om dit voorzichtig te doen (en liever eigenlijk niet te doen, maar soms moet het). We hebben het risico wel gemeld bij OG en dat hielp in de relatie. Koud in de Voortgangsrapportage opnemen werkt averechts.
- Door het risico te benoemen zei OG op een gegeven moment: “je hebt wel een punt”

1.7.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico (P17, 18, 21, 25 en 27)?

- Periode 17 is eigenlijk al wanneer het risico is ‘opgetreden’. De status in deze periode wordt meteen ‘beheerst’, omdat er vanuit wordt gegaan dat de OG na het benoemen van het risico ermee aan de slag gaat.
- In periode 18 was er geen verbetering te merken (door omgevingsmanager van OG), dus heeft de ON het risico verhoogt, om de OG zo hopelijk verder te activeren.
- Vanaf periode 21 heeft de omgevingsmanager OG zijn taken goed opgepakt en is het risico verlaagt, maar volgens de ON was dit nog niet voldoende.
- In periode 25 is er besloten om een aantal werkzaamheden naar de ON te verplaatsen om het risico te mitigeren. Dit is een onwenselijke situatie, maar omdat de ON hinder ervaart en de werkzaamheden niet voort kan zetten moest er actie ondernomen worden.
- Uiteindelijk zijn de werkzaamheden succesvol afgerond.

Interview met Procesmanager N244-N246

Silvester Pastoor

25-08-2021 – online via MS Teams

1.7.3. Reflectie op het risico

- Eigenlijk is dit risico een ‘issue’. Toch is het opgenomen als risico omdat de OG gemotiveerd/ geactiveerd moest worden om hier iets aan te doen.
- Beheersmaatregelen konden niet getroffen worden, omdat het risico en actie voor mitigerende maatregelen bij de OG lag. Daarom is er geen rest RISMAN en beheersmaatregelen opgenomen in Relatics.

Interview met Procesmanager N244-N246

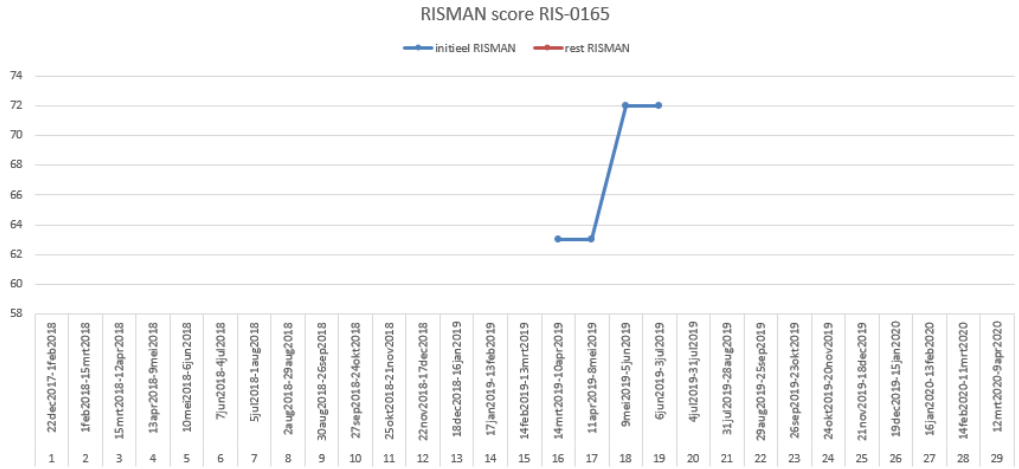
Silvester Pastoor

01-09-2021 – online via MS Teams

1. Risico's

1.1. RIS-0165

RegioRegie geeft geen toestemming voor asfalteringswerkzaamheden en eventuele overige werkzaamheden m.b.t. WOG's op de N244



1.1.1. Toelichting op het risico

- RegioRegie = Overkoepelend orgaan, waarin diverse organisatie vertegenwoordigd zijn (zoals nood- & hulpdiensten, vervoersbedrijven, bracheorganisaties (zoals scheepvaart en transport), waterschap en provincie)die er bijvoorbeeld voor zorgt dat niet tegelijkertijd alle wegen worden afgesloten (door werkzaamheden) waardoor bepaalde plekken onbereikbaar kunnen worden. Dit project valt in dezelfde regio als de Rijksweg A9 en de aan- & afvoerende wegen richting Alkmaar. Hierdoor moest er afstemming plaatsvinden met andere afsluitingen en wegwerkzaamheden, zodat Alkmaar en omgeving bereikbaar zou blijven.
- In een eerder interview hebben we een risico besproken wat hiermeesamenhangt. RegioRegieGedurende het project moesten wij onze werkzaamheden afstemmen op die van de Leeghwaterbrug (ander project van PNH). Om de renovatie van de N244a mogelijk te maken, moest deze worden afgesloten. Deze afsluiting mocht pas actief worden wanneer het project Leeghwaterbrug afgerond zou zijn. Door de vertraging op dit project kwamen wij in de problemen met onze mijlpalen.
- De werkzaamheden van Dura Vermeer aan de N244a zouden (voorstel van OG) verspreid worden over meerdere (5) weekendafslutingen om de drukte op het omliggende wegennetwerk te verlagen.Dura vermeer heeft een voorstel gedaan om dit aan te passen naar een volledig afsluiting van 2 volledige weekenden met een tussenliggende week om het werk uit te voeren. Deze wijziging was goedgekeurd door OG, maar

zou mogelijk een probleem kunnen zijn bij RegioRegie (ivm met de andere projecten in de omgeving).

1.1.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico?

- Vrij hoog risico want afkeuring van RegioRegie = geen werkzaamheden kunnen uitvoeren = veel extra kosten en uitloop op de planning.
- Beheersmaatregelen getroffen: informeren van RegioRegie over de situatie (ruim van tevoren), en de situatie toegelicht (verkeersmodellen doorrekenen) , zodat ze bijna niet anders konden dan het goedkeuren van de aanvraag.
- De toename in periode 18 komt doordat er nog steeds geen goedkeuring was, en de deadline steeds dichterbij komt (kans van optreden neemt toe). Tegelijkertijd zijn de consequenties accurater (en nemen deze af). Desondanks, is het resultaat van de RISMAN hoger dan in de vorige periode, door die naderende deadline.
- In periode 19 is het uiteindelijk goedgekeurd en zijn de werkzaamheden in één keer goed uitgevoerd

1.1.3. Reflectie op het risico

- We zijn door het oog van de naald gegaan. Echt net op het nippertje is het goedgekeurd door RegioRegie en konden we de werkzaamheden uitvoeren. De druk van dit risico heeft ons gedwongen om een strak plan neer te zetten, alles voor te bereiden en alles in één keer af te maken zonder restpunten of losse eindjes. Dit risico heeft er onder andere voor gezorgd dat de inzet van materieel, materiaal en personele bezetting tot op het uur gepland is. Hierdoor hebben we ook een grotere financieel resultaat kunnen neerzetten, doordat er geen faalkosten/verspillingen in deze voorbereiding zijn ontstaan.

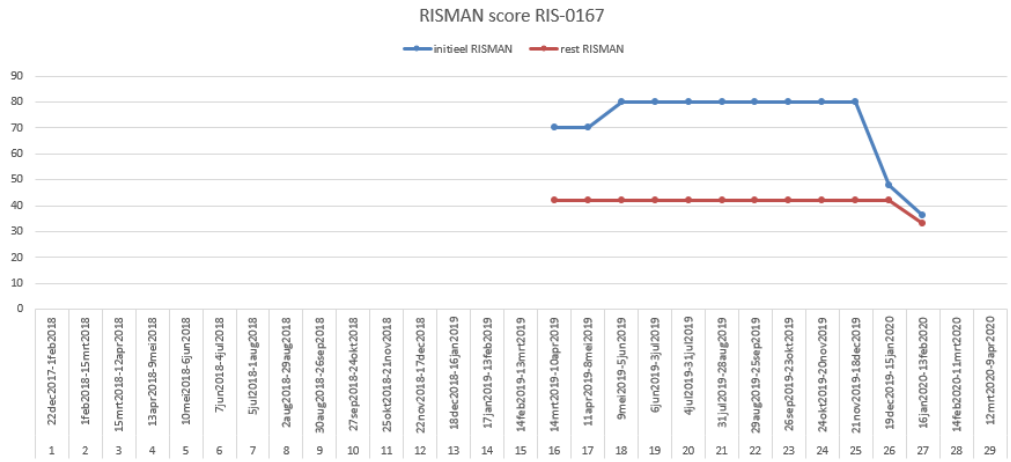
Interview met Procesmanager N244-N246

Silvester Pastoor

01-09-2021 – online via MS Teams

1.2. RIS-0167

Dura Vermeer krijgt haar op- en afleverdossiers niet binnen de gestelde planning geaccepteerd



1.2.1. Toelichting op het risico

- Provincie Noord-Holland staat bekend om het “niet makkelijk akkoord geven” op opleverdossiers. Dit is algemeen bekend bij aannemers.
- Er stond een ongebruikelijke eis in het contract, namelijk dat de opleverdossiers binnen de mijlpaal goedgekeurd moesten worden. Normaal is de mijlpaal de deadline voor het in gebruik nemen van het object en komen de opleverdossiers erna.

1.2.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico?

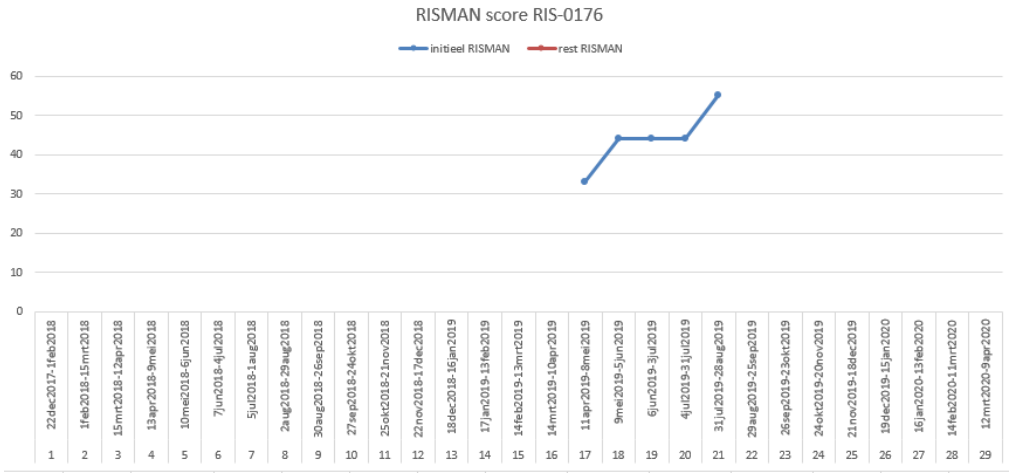
- Het risico is vroeg aangekaart bij OG
- OG wilde deze eis (opleverdossier goedgekeurd voor de mijlpaal) niet aanpassen, maar uiteindelijk is er een wijziging overeengekomen. Er zat namelijk ook een groot voordeel in voor OG.
- de afname is als gevolg van de goedgekeurde documenten, dus de kans dat volgende documenten ook te laat worden goedgekeurd neemt (geleidelijk) af. Acceptatie van Annex III documenten, zijn ook onderdeel van een Opleverdossier. Deze zijn dus reeds bekend en geven geen discussie meer.

1.2.3. Reflectie op het risico

- Waarom geeft PNH laat of moeilijk akkoord?
  - administratie is slecht/ niet op orde
  - veel inhuur, dus weinig (lange termijn) kennis over de organisatie en processen, of bekend met eerder genomen besluiten of afspraken
- Dit risico is een ‘zuiver voorbeeld’ van inzet van de risicoscore in de communicatie met de OG. Het risico had kunnen worden verlaagd, maar er moest nog veel werk gedaan worden (door OG en Silvester zelf) als gevolg van dit risico (vb gehele mappenstructuur moest worden herzien), dat de risicoscore hoog is gebleven.

- Achteraf is alles goed gegaan. Het werk is op tijd gereed, en de opleverdossiers zijn uiteindelijk ook binnen de initieel gestelde mijlpaal goedgekeurd. Voor Dura Vermeer is dit een van de successen geweest van dit project.

1.3. RIS-0176
Omgevingsvergunning fietsbrug Noorddijk wordt niet (tijdig) verleend



1.3.1. Toelichting op het risico

- Bij de kruising Noorddijk moest de kruising vernieuwd worden en de layout aangepast.
- De OG had een ‘rechte fietsbrug’ in het referentie ontwerp getekend, maar de 2 fietsbruggen hadden veel tegenstrijdige eisen. Door de eisen goed uit te werken is ON erachter gekomen dat de combinatie van deze eisen nooit kan leiden tot de eenvoudige ‘rechte brug’ die in het referentieontwerp stond. Hierdoor moest er een nieuwe aanvraag gedaan worden voor een omgevingsvergunning.

1.3.2. Wat is er gebeurd in het project ten tijde van de wijzigingen van het risico?

- Het ontwerp werd goedgekeurd door OG, maar moest dus nog opnieuw worden ingediend voor omgevingsvergunning.
- In eerste instantie werd de leuning van het ontwerp niet goedgekeurd. (periode 17?) Daardoor moest ON terug naar de tekentafel en in overleg met OG. En beheersmaatregelen zijn getroffen.
- De brug zou ondergebracht worden bij een nieuwe beheerder, (Gemeente Zaanstad) die het vervolgens weer oneens was met de vernieuwde leuning. Dit was dus een intern conflict in de organisatie van de gemeente, waarbij ze niet eenduidig waren in de keuzes voor een leuning. De 2 afdelingen: Welstand en Bouw- & Woningtoezicht konden het niet eens worden. Beheersmaatregel BM0508 is uitgevoerd om te helpen bij dit conflict.

- Omdat ze er steeds maar niet uit komen, neemt het risico toe, want hoe langer er wordt gewacht met een keuze maken, hoe hoger de kosten en uitloop (consequenties) zijn.
- Uiteindelijk 3 weken voor de uitvoering is de keuze gemaakt.

1.3.3. Reflectie op het risico

- We zijn door het oog van de naald gegaan. De goedkeuring is echt op het nippertje verleend.
- Het conflict/ oorzaak lag volledig intern bij OG, waardoor ON er weinig aan kon doen. Het heeft wel enorm veel extra tijd gekost van het project team van ON, die eigenlijk besteed had moeten worden aan andere taken. Hierdoor heeft dit risico geleid tot indirecte vertraging van andere werkzaamheden.

Interview met Procesmanager N244-N246

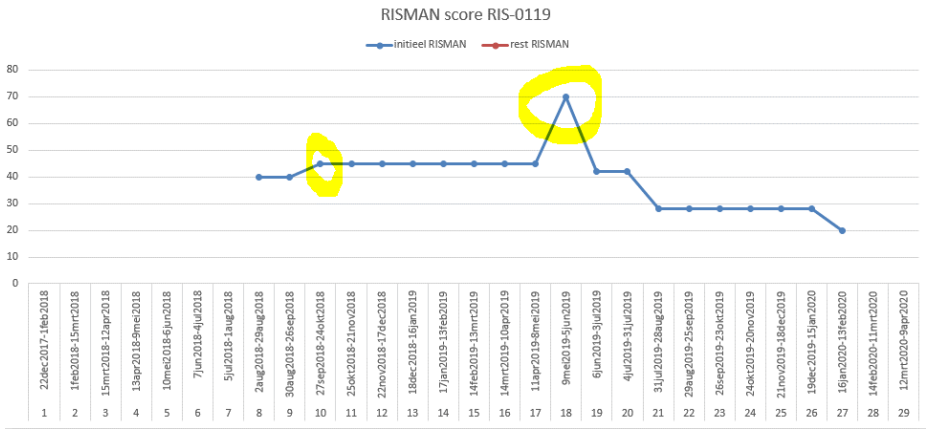
Silvester Pastoor

23-11-2021 – mailcontact

Het onderzoek is in de afrondende fase, en tijdens de bespreking met de TU afgelopen maandag hebben we besloten nog een kleine verdiepingsslag te maken op het onderzoek. Hiervoor heb ik nog een paar vragen voor jou. Komt het uit om dit op korte termijn aan jou te vragen? Dit kan via de mail, maar een (online) meeting van een half uurtje moet ook voldoende zijn.

In de bijlage van de mail heb ik alvast toegevoegd voor welke veranderingen in RISMAN score ik nog een verklaring zoek. Ik kijk uit naar je reactie.

1. RIS-0119 “Wisselingen van de wacht in het team van OG”



1.1. Datum toename: 24-10-2018

1.1.1. Toename in Tijd

1.1.2. Wat is de reden van de toename?

- Dit ging toentertijd om de acceptatie van een deel van het DO en een UO van de Prinses Amaliabrug. Er was toen een nieuwe contractmanager aangeschoven en een technisch manager werd vervangen. Toen werden toetstermijnen door OG overschreden en waren wij veel tijd kwijt aan het meenemen van de nieuwe medewerkers van OG. Wij verloren toen onze buffers aan problemen van OG.

1.2. Datum toename: 28-05-2019

1.2.1. Toename in Imago en Omgeving

1.2.2. Wat is de reden van de toename?

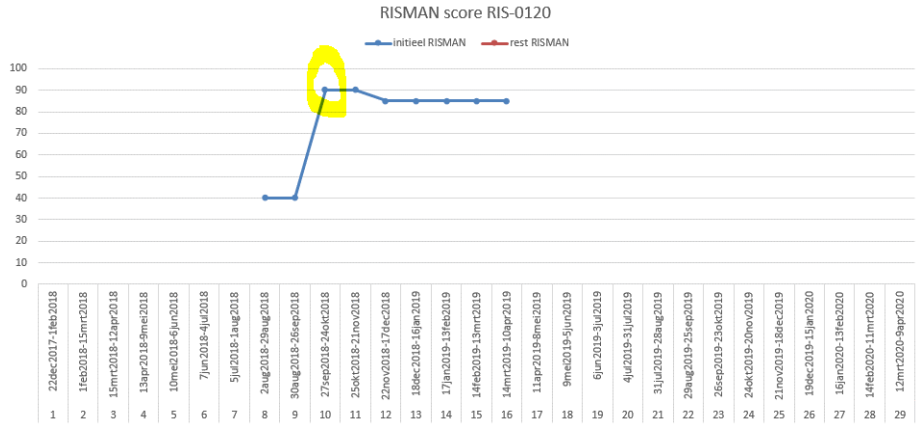
- Als gevolg van bovenstaand maakte we ons zorgen over het halen van de mijlpaal rondom de ingebruikname van de Prinses Amaliabrug. OG was toentertijd meer met zichzelf bezig dan met de voortgang van het project. Bij het niet behalen van de mijlpaal krijg je verkeerde berichtgeving in de media (imago) en de omgeving dreigde in opstand te komen

Interview met Procesmanager N244-N246

Silvester Pastoor

23-11-2021 – mailcontact

2. RIS-0120 “Restlevensduur van het totale asfaltpakket is lager dan de door OG verstrekte metingen aangeven”



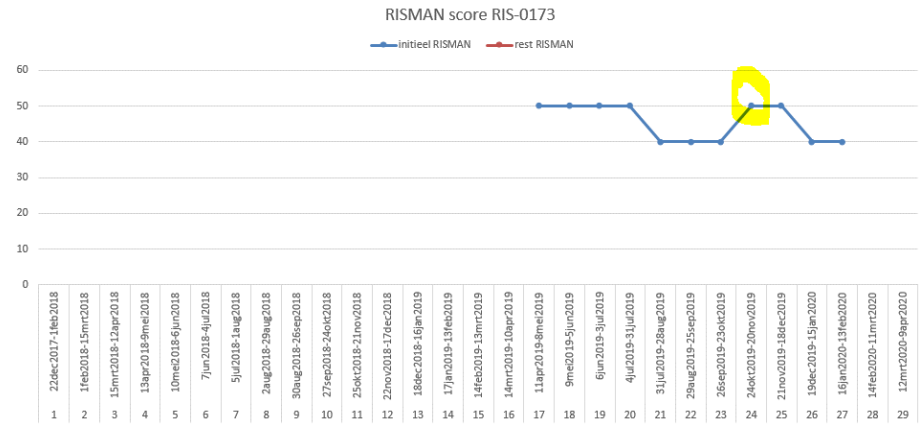
2.1. Datum toename: 24-10-2018

2.1.1. Toename in Kans, Geld, Imago, Omgeving en Tijd

2.1.2. Wat is de reden van de toename?

- Wij hebben de informatie van OG gecontroleerd rondom de kwaliteit van het asfalt van de N244a. Dit bleek veel slechter te zijn, en daardoor moest er veel meer onderhoud uitgevoerd te worden. Daarbij hadden we natuurlijk ook het risico dat RegioRegio ons geen toestemming zou geven om de N244a af te sluiten.

3. RIS-0173 “Uitvoeringsteam Dynniq heeft niet de juiste uitgangspunten om de werkzaamheden voor te bereiden”



3.1. Datum toename: 30-10-2019

3.1.1. Toename in Kans: van 4 weer terug naar 5

3.1.2. Wat is de reden van de toename?

- Dynniq liet weer eens zien dat ze hun eigen werkzaamheden niet konden plannen. De coordinatie bij de Kogerpolderbrug dreigde nog verder in de soep te lopen en trad eigenlijk gewoon op. Daarom de stijging, ook om OG te motiveren om te acteren.

Interview met Procesmanager N244-N246

Silvester Pastoor

14-12-2021 – Online via MS Teams

Tijdens de uitwerking en toelichtingen schrijven voor het rapport zijn er nog een paar vragen ontstaan over de risico's. Deze kleine puntjes zijn in dit overleg besproken.

1. RIS-0172 en RIS-0184
   1.1. Is RIS-0172 echt niet opgetreden? Hoe is anders RIS-0184 geidentificeerd?
      - De bewoners woonden vlakbij de Kogerpolderbrug. Door onze werkzaamheden zijn er trillingen in de woning, maar die trillingen hebben de gemelde schade niet veroorzaakt. De oorzaak van die kleine schade kwam door eigen activiteiten van de bewoners.
      - Wel merkten we dat deze bewoners niet tevreden waren over de werkzaamheden. Dit had ook te maken met het feit dat de OG hun niet goed had meegenomen in het proces.
      - Door de eerder besproken Task Force moesten enkele wijzigingen worden gemaakt, en dus ook nieuwe vergunningen, etc. aangevraagd worden. Vanwege de houding van de bewoners tegenover het project is RIS-0184 geïdentificeerd.

2. RIS-0109
   2.1. In een vorig overleg had je aangegeven dat de OG onjuiste informatie had doorgegeven over de status van de glasvezelkabels. Denk je dat de OG dit ook niet wist, of waren ze wel op de hoogte van de huidgie status?
      - Waarschijnlijk wist de OG ook niet van de status van de glasvezelkabels. De provincie is een grote organisatie met veel afdelingen, dus waarschijnlijk was de communicatie onderling niet voldoende of frequent genoeg om te weten of de werkzaamheden al uitgevoerd warem.

3. RIS-0165
   3.1. Na verdere analyse lijkt de oorzaak van dit risico niet helemaal meer te kloppen. Zou je de context van dit risico nog eens kunnen toelichten? En wat is nu echt de oorzaak, en wat is bijzaak?
      - De oorsprong van dit risico zit in de opgestelde eis in het contract om niet tegelijk te kunnen werken aan de N244 als het andere project bij de Leeghwaterbrug. Omdat dat project uitliep, zouden wij uitlopen tot buiten onze contractuele mijlpalen. Daarom is er gekeken naar alternatieve oplossingen in de planning.
      - Er is gezamenlijk (met instemming van OG en beheerder) besloten om de werkzaamheden in 2 weekenden en 1 week te passen in plaats van 5 losse weekenden. Dit was ook efficienter en voordeliger voor Dura Vermeer, en hier hebben we veel kosten op bespaard.
      - Nu moest het alleen nog worden goedgekeurd door RegioRegie. En daar konden wij geen invloed op uitoefenen.

Interview met Kostendeskundige Dura Vermeer Landelijke Projecten

Joost Kuijs

05-07-2021 – Online via MS Teams

De structuur van het budget van Dura Vermeer wordt onderzocht om een vergelijking te maken met de structuur voor budgetten uit de literatuur. Het doel van het onderzoeken van de structuur van het budget is om te begrijpen wat er wel en niet in de risico reservering wordt opgenomen en hoe andere contingenten worden gebruikt.

Joost Kuijs is van de afdeling Calculatie binnen Dura Vermeer en heeft veel kennis van budgetten en kosten. Hij heeft een document gedeeld waarin het budget van een project normaliter in de tenderfase mee wordt opgebouwd. Op basis van deze excel heeft hij toegelicht wat alle kostenposten inhouden en bij sommigen ook hoe ze berekend worden. En samenvatting van dit gesprek is hieronder gedocumenteerd.

Het budget bestaat uit de volgende componenten:

- **Directe kosten**
  Dit zijn kosten zoals materiaal, maar ook de preventieve beheersmaatregelen uit het Kansen & Risico dossier (van de tender)

- **Algemene bouwplaats kosten**
  Er is onderling discussie of dit nu directe of indirecte kosten zijn. Daarom heeft het zijn eigen categorie

- **Indirecte kosten**
  Deze is nog onder te verdelen in verschillende componenten.
  - **Projectorganisatie, engineering, financieel, procesbeheersing, etc.**
  - **Kans & risico's**
    - **Geïdentificeerde risico's**
      Inclusief correctieve beheersmaatregelen
    - **Geïdentificeerde kansen**
      Bevat kortingen voor het budget op basis van kansen uit de tender
    - **Scheefte**
      Wordt berekend door het verschil tussen de berekende kosten uit een Monte Carlo analyse en de deterministisch bepaalde kosten.
    - **Onzekerheidsreserve**
      Dit is een extra buffer voor complexe projecten. Het wordt berekend door het gemiddelde van P15 en P85 van de Monte Carlo analyse afhankelijk (incl. index en prijsfluctuatie) en Monte Carlo analyse onafhankelijk vermenigvuldigd met 30% (niet alle projecten hebben 100% van deze buffer nodig
  - **Opslagen**
    - **Algemene kosten**
    - **Winst**

Interview met Kostendeskundige Dura Vermeer Landelijke Projecten

Joost Kuijs

05-07-2021 – Online via MS Teams

- **Onvoorzien**
  Komt vaak neer op ongeveer 2% van het project budget, maar is afhankelijk van het verloop van de tender, beschikbare informatie, etc. Dit is niet om risico's te dekken, maar voor grote onvoorspelbare gebeurtenissen.

Overige opmerkingen:

- Indexen en fluctuatie worden vaak door de OG betaald.
- Verzekeringen kunnen afgesloten worden voor bepaalde risico's (doorlopend voor Dura Vermeer, of per project).

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

08-09-2021 – DV kantoor Rotterdam

*tekst in grijs zijn antwoorden en opmerkingen van Ruben

1. Wat was de rol van Ruben in dit project?
    - Integraal planner, vanaf opstart project in december 2016 t/m afronding in april 2021.
    - Laatste jaar (vanaf januari 2020) werden de taken als integraal planner en risicomanager kleiner, dus zijn deze beide uitgevoerd door 1 persoon. Ruben heeft deze taken van de risicomanager overgenomen

2. Definitie en gebruik van initieel en rest RISMAN score
    2.1. Wanneer wordt de initiële RISMAN score gebruikt?
        - Bij de 1e keer dat het risico wordt gezien en ingevoerd in Relatics. Deze score wordt daarna nooit meer aangepast. Het initiële risico blijft.
    2.2. Wanneer en hoe wordt de rest RISMAN score gebruikt?
        - Om het actuele risico uit te drukken. Dit houdt in dat de huidige situatie wordt beoordeeld, en er meegenomen wordt welke beheersmaatregelen al getroffen zijn en hun effectiviteit op de beheersing van het risico.
        - Restrisico is in dit geval dus niet de situatie waarin aangenomen wordt dat alle beheersmaatregelen uitgevoerd en effectief zijn.
    2.3. ‘Rest RISMAN > initieel RISMAN’ is dus een mogelijk scenario, omdat initieel RISMAN altijd gelijk blijft?
        - Ja dat klopt. Alleen moet bij de 1e invoer dit niet het geval zijn. Dan zijn je beheersmaatregelen niet geschikt (want dan leiden deze tot een verhoogd risico in plaats van verlagend). In de loop van tijd kan het risico wel toenemen: dat wordt dan verwerkt in rest RISMAN

3. Rapportage
    3.1. Wat is het verschil tussen de rapportages VO1 t/m VO4 en Termijn 1 t/m 45?
        - Officieel zouden we pas vanaf 1 januari 2017 betaald krijgen (volgens de termijnstaten/ contract). Maar er moest wel het een en ander aan voorwerk gebeuren, zoals planuitwerking en ontwerpwerkzaamheden. Daarom hebben we in samenspraak met OG besloten om dit vast te leggen en dus ook betaald te krijgen voor het voorwerk (voor januari 2017). De OG wilde alleen graag dat dit dan een andere naam had in de voortgangsrapportages. vandaar de afwijkende naamgeving.
    3.2. In het begin zijn de initiële RISMAN scores gerapporteerd, waarom?
        - Het risicomanagement proces moet nog opgestart worden. Dus t/m termijn 2 zijn de risico’s vanuit de tender gebruikt en daarvan de initiële RISMAN scores gerapporteerd.
    3.3. Wat is de reden voor het onderscheid in PB risico’s (vaak top 5) en MM risico’s (vaak top 15) in de rapportage?
        - OG en ON hadden een aparte, eigen risicodossier. Ze rapporteerde elk hun risico’s in elke voortgangsrapportage.
        - Er is gekeken en overleg geweest hoe die dossiers het beste kunnen worden samengevoegd, zodat er meer samenwerking en inzicht ontstaat. Hier is uitgekomen dat in de VGR voortaan de top 5 PB risico’s en top 15 MM risico’s worden uitgelicht.
        - OG risico’s zijn verantwoordelijkheid van OG, ook in beheersing, maar kunnen effect hebben op ON. Dus worden ze op deze manier besproken. ON kan

adviseren aan OG om vb effectieve beheersmaatregelen te treffen, maar ON zal zelf geen beheersmaatregelen hoeven nemen voor een OG risico.
- Zie ook het stukje op DV sharepoint omgeving: blog over dit project en hoe er samengewerkt wordt. Mantra “jouw probleem is mijn probleem is ons probleem”
- Er was in dit project een goede samenwerking met de OG

3.4. Er worden top 5/ top 15/ top 20 risico’s gerapporteerd, maar wordt er ook naar de risico matrix? Worden risico’s beoordeeld op zichzelf, en is er een minimum RISMAN score waarmee je het risico accepteert?
- In de rapportage wordt inderdaad altijd gekeken naar de grootste risico’s, met de hoogste RISMAN score. Dit is in dit geval een top 20 (of top 5 + top 15). We kijken niet naar een bepaalde RISMAN waarde. Dat zou in toekomstige projecten wel interessant zijn. Wel werd om de zoveel tijd in een MT-overleg vanuit een andere invalshoek, gelijkwaardig aan de risico-matrix, gekeken naar hoe risico’s zich in totaliteit verhouden tot het project.

3.5. Het is interessant dat er bijna geen kritieke, zogenoemde ‘rode’ risico’s zijn (afgelezen vanuit de matrix). Was dit een makkelijk/ laag-risico project?
- Mogelijk zijn we optimistisch in het inschatten van de risicoscores
- Mogelijk hebben we in het begin van het project de risico’s laag ingeschat. Dit blijft tijdens het project een maatstaf voor het kwantificeren van risico’s in het risicodossier.
- Dit project werd gekenmerkt door een grote hoeveelheid laag gewaardeerde risico’s, doordat er ontzettend veel kleine risico’s waren met in de meeste gevallen ontzettend veel beheersmaatregelen mogelijk waren. Toch was het zeker geen laag-risico project, aangezien alle risico’s en beheersmaatregelen enorme invloed op elkaar hadden. Hierdoor ontstaat een risico op een sneeuwbaleffect, waarbij het optreden of juist beheersen van risico X meerdere risico’s kon verhogen (zie bijv. RIS-0373 Project kan niet worden gerealiseerd conform de projectdoelstellingen en/of aanbieding (sneeuwbaleffect)).

4. Te analyseren risico’s

4.1. Welke type risico’s zijn geschikt voor analyse met betrekking tot dit onderzoek? Ik ben in eerste instantie op zoek naar opgetreden risisco’s, maar hoe zou jij de selectie maken? Wat waren kritische risico’s voor dit project?
- Risico RIS-0382 t/m RIS-0407 moet je uit je analyse laten. Deze zijn later samengevoegd tot grotere risico’s. Dit was een soort ‘werkdocument’ voor het inschatten van meerwerk, waarbij we geen andere middelen hadden om een probabilistische planning te maken. Dus dit deel is in Relatics gedaan met risico’s, maar nooit meegenomen in risicorapportages.
- OG risico’s zijn niet onze verantwoordelijkheid, dus wij treffen ook geen beheersmaatregelen, en is ook niet interessant om te analyseren.
- RIS-0373 is een voorbeeld van een ‘container’ risico, waarbij we meerdere kleine risico’s (met een relatief lage RISMAN score) hebben gebundeld, om zo het risico in de VGR te kunnen rapporteren aan de OG. De kleine risico’s hadden een gemeenschappelijke oorzaak/ domino effect, dus het was logisch om ze te combineren.

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

08-09-2021 – DV kantoor Rotterdam

4.2. Verder wil ik alvast enkele risico's bespreken die mij zijn opgevallen. In latere intereviews wil ik graag hiermee verder gaan.

4.2.1. RIS-0282

4.2.1.1. Toelichting risico

- Vrijgave = vrijgeven van werkgebied
- Het project bestond uit veel verschillende percelen en projectgebieden, waarbij er dus per perceel een vrijgave moest plaatsvinden. Als we ergens aan de slag wilde, dan ging omgevingsmanagement er eerst langs om de omgeving te informeren en mogelijk overhalen. Maar ook moet er voor de start van werkzaamheden vrijgave zijn op de onderwerpen ecologie, niet-gesprongen explosieven, archeologie, kabels & leidingen en eventueel verkeer en vergunningen.
- Het gebeurde weleens dat we dan op een perceel aankwamen waar de omstandigheden het niet toelieten om te starten met het werk (vb beschermde eekhoorn, kabels en leidingen, maar ook ontwerp gerelateerde problemen). Hierdoor weken we uit naar een ander perceel, om toch te blijven werken, maar daar was omgevingsmanagement nog niet langsgeweest, en dan hadden we weer een boze boer achter ons aan om ons van zijn land af te jagen. De afstemming met de perceeleigenaren (voor de start van de uitvoering) was dus slecht.
- Er waren geen procesafspraken gemaakt met OG rondom de (on)beschikbaarheid van de percelen en op het moment dat we dan, door wijzigingen in de planning, op een ander perceel wilde starten was de vrijgave van dat perceel nog niet op orde.

4.2.1.2. Toename en afname risico:

- We merkten dat het fout ging bij sommige percelen, dus hebben we het risico opgewaardeerd d.m.v. verhoogde kans van optreden.. Ook de effecten bleken hoger te zijn dan dat we initieel hadden ingeschat.
- Door het niet stil willen zitten en door willen blijven werken, waren veel percelen/ werkpakketten gedurende het project opgesplitst in kleinere delen, en waren er veel open eindjes (op veel plekken was wel iets gedaan, maar het kon nog niet afgerond worden). Hoe meer van dit soort 'conditionele' startpunten voor het afmaken van het werk, hoe meer 'vrijgave procedures' er bij kwamen. Hierdoor nam het risico toe.
- Daarna ging het beter door gebruik te maken van een GIS kaart met een kleurcode per beschikbaar perceel
- Op een gegeven moment was de situatie onder controle en nam het openstaand werk en aantal percelen af, en daarmee ook het risico.

4.2.1.3. Notities en overige opmerkingen

- ON was verantwoordelijk voor het werken op een vrijgegeven werkgebied. Het organiseren van verleggingen K&L is hier onderdeel van. De daadwerkelijke verlegging moest door K&L-beheerders uitgevoerd worden, die voor toestemming weer afhankelijk zijn van overheidsinstanties, of vaak zelf een overheidsinstantie zijn.

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

20-09-2021 – DV kantoor Utrecht

Dit interview is ingepland om specifieke risico's te bespreken. De vorige keer is RIS-0282 al kort besproken. Die hoeft nu niet verder besproken te worden.

1. Selectie risico's is gemaakt op basis van voorwaarde 'rest > initieel'. In dit project is restrisico gebruikt om actueel risico aan te geven.
    - Als bij de invoering van het risico rest als hoger is dan initieel, dan gaat er procesmatig iets fout, maar als rest na invoering hoger wordt dan initieel, dan is dat een toenemend risico.
    - Het kan zijn dat het risico al eerder was opgenomen in het risicodossier, maar dat rest RISMAN niet hoog genoeg was om in de top 15/20 te eindigen (en dus niet in de VGR is opgenomen). Deze info is nu ook niet op te halen uit Relatics, dus gebruiken we toch deze selectiecriteria.
    - Er mag aangenomen worden dat wanneer het risico niet gerapporteerd is in VGR, de rest RISMAN score dan in ieder geval lager dan laagste RISMAN score in VGR (normaal 15-18).

Wederom geen filter/ selectie mogelijk om te selecteren op opgetreden risico. Daarom is toename van risico is interessant om te analyseren. Hadden ze het kunnen zien aankomen dat het risico toeneemt? En is het risico uiteindelijk opgetreden?

2. Algemene opmerkingen van Ruben
    - Bij risico's met afhankelijkheden van andere partijen zijn de beheersmaatregelen en andere notities goed genoteerd en gedocumenteerd. Dit werd gezien als opbouw van dossier om te laten zien wat er allemaal al aan actie ondernomen was.
        - Dit werd gedreven vanuit een inspanningsverplichting die via EMVI criteria/ tender belooft zijn: toch doorgaan (vb op andere percelen of met andere taken) ondanks dat je ergens niet aan de slag kan (volgens de planning). Ondanks diverse obstakels dient voortgang geboekt te worden.
    - Richting het einde van het project werden soms oorzaken verwijderd of beheerst (in notitie), als de oorzaak niet meer kon optreden. (In Relatics)

3. Risico's
    3.1. RI-055
        3.1.1. Algemene toelichting
            - K&L risico: niet op tijd verlegd. Verleggen van K&L is een lang proces met veel partijen. Voorbereiding tot daadwerkelijk verleggen heeft een lange doorlooptijd.
        3.1.2. Veranderingen in RISMAN score
            - Tot T36 geen grote impact, omdat er voldoende tijd was om het werk te realiseren. Als er ergens K&L nog niet verlegd waren, konden we altijd ergens anders aan het werk.
            - Risico is toegenomen, omdat de deadline van uitvoering dichterbij kwam.
            - na bespreking met MT: beheersmaatregel = met OG bespreken
            - na OG overleg, toch risicoscore omhoog
            - Vanaf T37: escaleren, omdat resterende tijd tot laatste mijlpaal van project beperkt was: bijna niet voldoende tijd om het te maken object te realiseren.

- T39: extra afstemming en overleg heeft plaatsgevonden om beschikbare informatie en samenwerking te verbeteren
- T40: aantal K&L neemt af, maar qua tijd zitten we erg dicht bij einddatum oplevering, dus de K&L overgebleven, zijn wel enorm kritiek. Specifieke risico's aangemaakt.
    - Opmerking uit Relatics" T40: Voor de risicovolle k&l zijn specifieke risico's aangemaakt (RIS-0426/427/428/429). Hierbij is de focus van het risico gelegd op het concreet niet kunnen afronden van objecten, met als oorzaak niet tijdige de K&L-verlegging. Hiermee konden we de impact van de vertraagde K&L beter duidelijk maken bij opdrachtgever. Dit project breed georiënteerde risico wordt daarmee afgewaardeerd."

3.2. RIS-0239

3.2.1. Algemene toelichting

- Risico = niet kunnen uitvoeren van correctieve BM wanneer mbt flora en fauna.
- Organisatie die dit moet goedkeuren reageert traag/slecht
- Lessons learnt bij dit risico: escalatie heeft gewerkt. Blijkbaar is dit (escalatie) nodig om een overheidsinstantie in beweging te krijgen. Escalatie is in samenwerking met PB (OG) gedaan: druk uitoefenen (van 2 kanten). Dit komt vanuit het eerder besproken gedachtegoed: "jouw probleem, is mijn probleem, is ons probleem,".

3.2.2. Veranderingen in RISMAN score

- Rond T10 veel BM uitgevoerd
- Kans op vertraging van werk neemt toe (T23), risico komt steeds dichter bij beïnvloeden van kritieke pad.

3.3. RIS-0357

3.3.1. Algemene toelichting

- Er was afgesproken met de OG dat het werk op tijd afgerond kon worden als er op 1 januari 2020 toegang was tot het terrein (voorheen niet beschikbaar). Dit was verantwoordelijkheid van OG.
- Volgorde van werk:
    1. Terrein X beschikbaar
    2. Rondweg realiseren op terrein X (naast centrum Wanssum)
    3. Werk realiseren in centrum Wanssum (verkeer kan omgeleid worden over nieuw aangelegde rondweg uit vorige stap)
- Stap 3 is eigenlijk een gevolg van risico in stap 1. Maar omdat de gevolgen zo groot zijn van dit specifieke gevolg is het als apart risico opgenomen in het risicodossier.
- Werkzaamheden centrum Wanssum stond gepland voor de laatste 10 weken van 2020 (oktober tot en met december).

3.3.2. Veranderingen in RISMAN score

- OG heeft altijd gezegd: 1 januari kunnen jullie daar aan de slag. Daardoor ging het risico niet omhoog. En toen was het 1 januari… en het terrein was niet beschikbaar.
    - Risico van stap 1 is dus opgetreden. De kans dat we op tijd kunnen beginnen met de werkzaamheden in centrum Wanssum wordt kleiner (kans van optreden risico neemt toe). Het werk in het centrum van Wanssum (dit risico) ook in het gedrang.

- T45: mijlpaal (vervroegd) behaald op een ander werk/ risico, daardoor kon dit risico afgeschaald worden. Er was een directe afhankelijkheid tussen deze 2 risico's.

3.4. RI-009

3.4.1. Algemene toelichting

- Uitwateringskunstwerk = doorgang tussen binnen en buitendijks (door de dijk)
  - wanneer er in binnendijks gebied te hoog water is (sloten te vol), dan moet het water naar buitendijks gebied worden afgevoerd (in dit geval de Maas)
- Er was onvoldoende informatie vanuit het contract beschikbaar om dit (ontwerp, hoeveelheden, tijd, geld) goed in te kunnen schatten
- Risico: er was mogelijk meer geld nodig om dit nog onbekende aantal kunstwerken te realiseren

3.4.2. Veranderingen in RISMAN score

- Toelichting in Relatics is op periode eind 2018. Risico in VGR en toename risico eind 2017…
- Onvoldoende info nu beschikbaar om dit risico verder te bespreken.

3.5. RIS-0151

3.5.1. Algemene toelichting

- IL&T = bedrijf dat moet controleren of bedrijven (MM) volgens de vergunningsvoorschriften werken, namens Rijkswaterstaat (beheer).
- IL&T = ILT. Keurt rapporten goed of af, voert inspecties uit, etc.
- Dit is weer een risico met afhankelijkheid van een externe partij
- Risico is overgezet naar RIS-0235 (vervolg risico).

3.5.2. Veranderingen in RISMAN score

- Toename van RISMAN in T10 is waarschijnlijk een foutje
- Document/ werkzaamheden zijn goedgekeurd in T22.

3.6. RIS-0314

3.6.1. Algemene toelichting

- NOG = niet onderzochte archeologische gebieden (vanuit tender nog niet beschikbare info): OG heeft dan geen info over de gebieden. ON moet dit zelf onderzoeken tijdens project.
- Plan om april 2018 te starten. Werkzaamheden tot oktober 2018 (erna hoogwater)
- Het idee was om klei uit het gebied zelf te gebruiken (opgraven op de ene plek en gebruiken op de andere plek). Dit was ook een EMVI belofte en belangrijke besparing op de kosten.

3.6.2. Veranderingen in RISMAN score

- T16 (april 2018) verhoging naar 30
  - Uit VGR: "Ook is RIS-0314: 'Materiaal niet tijdig beschikbaar om het grondwerk te realiseren' nieuw in de top 15 van het risicoregister. Dit komt omdat MM steeds meer last in de planning ondervindt dat locaties waar materiaal vrij moet komen om het grondwerk te realiseren nog niet vrij zijn gegeven op conditionering (bijvoorbeeld op archeologie op de ontgravingslocatie van Dijkring Broekhuizen). Om dit risico te beheersen stuurt MM op de vrijgave van de winlocaties

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Ruben van der Zanden

20-09-2021 – DV kantoor Utrecht

(BM-1888) en houdt MM de productielijnen bij om samen met PB keuzes te maken om dit risico te kunnen beheersen, bijvoorbeeld aankoop van klei (BM-2071).”

- T17 en 18 verhoging naar 40
    - Uit VGR: RIS-0314 - Materiaal niet tijdig beschikbaar om het grondwerk te realiseren; Het risico dat materiaal niet tijdig beschikbaar is uit de niet onderzochte gebieden (archeologie) om het grondwerk te realiseren (RIS-0314) is de afgelopen periode groter geworden. Dit komt omdat er nog geen overeenstemming is over de uitvoeringsmethode van het archeologisch onderzoek. Op de korte termijn ligt de focus erop om het hier met elkaar over eens te worden, zodat MM het onderzoek kan voortzetten en de gebieden kan vrijgeven. Indien het onderzoek leidt tot opgraving, ontstaat er een nieuw risico. Daarnaast monitort MM de werkelijke productie irt benodigde productie, om (samen met PB) gericht keuzes te kunnen maken om dit risico te beheersen. Dit kan bijvoorbeeld door klei aan te kopen (BM-2071). Dit risico drukt vooral op de planning en is daarom op dit moment het grootste risico van het project.
- Begin juli 2018 duidelijkheid over vrijgave (T19): RISMAN van 40 naar 16
- week 1 oktober is gesprek tussen PB MM + BAAC
- Vertraging van ongeveer 3 maanden (juli ipv april)
    - Er wordt pas actie ondernomen door MM in april om de locaties te onderzoeken
    - MM heeft aan OG aangegeven dat ze flexibel zijn (als we op locatie 1 niet aan de slag kunnen, dan gaan we op 2 wel aan de slag) dit kan niet oneindig doorgaan. Er zijn dus wel werkzaamheden gedaan in die 3 maanden (andere).
- Hoe kunnen we aan OG laten zien dat we wel ons uiterste best doen om te werken waar we kunnen werken. Maar dat met die inspanning niet het geplande werk gehaald kon worden.
    - We zijn de productie van klei/ grond gaan monitoren
    - Daarmee kan je laten zien dat we niet voldoende produceren om werk te halen/ maken. Daarom is het risico omhoog gegaan. (resultaat van BM zichtbaar hierdoor)
    - Monitoren heeft het volgende opgeleverd: bewijs aan OG & inzicht voor ON
- Uiteindelijk zijn gebieden vrijgegeven, dus productie kon doorgezet worden.
- Besluitvorming van de laatste 20% van de NoG gebieden is vertraagd. Hierdoor restrisico omhoog. [25-10-2018] (T23): RISMAN van 16 naar 21
    - Bij 80% van NOG ging het prima, maar bij 20%, ondanks BM, anders gelopen dan verwacht of afgesproken: dus risico gaat omhoog

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

20-09-2021 – DV kantoor Utrecht

4. Overige opmerkingen
   4.1. Opvallende waarnemingen tijdens analyse van risicodossier in VGR's: 65 risico's in VGR met initieel = rest. Hoe komt dit? Waarom geen beheersmaatregelen? Of waarom niet effectief? Bij acceptatie van het risico, moet het dan nog wel in VGR? Hieronder enkele toelichtingen op mogelijke oorzaken van dit fenomeen. Het zijn er te veel om alle 65 individueel uit te zoeken. Dit is meer een reflectie/ kritische blik op risicomanagement van het project in algemene zin.
   - Mogelijk zijn de risico's geaccepteerd. Dit zou je in Relatics kunnen terugzoeken.
   - Risico's door afhankelijkheid van externe factoren/ partijen: geen invloed op optreden of beheersen van risico. Daarom geen beheersmaatregelen kunnen treffen om risico te beheersen.
   - Hoe dichter bij de einddatum: hoe kleiner de kans dat hij optreed. (vb RIS-0209)
   - Mogelijk dat beheersmaatregelen inderdaad niet effectief zijn
   - Er is niet in 1 oogopslag te zien wat er met het risico is gedaan: risicostrategie.
     - Dit zou wel handig kunnen zijn in dit soort gevallen: is het risico geaccepteerd? Worden er beheersmaatregelen uitgevoerd om het te verlagen (maar zijn ze dus niet effectief)? Etc.
     - Het is iets dat speelt binnen GRIP (kennisdeling binnen Dura Vermeer Projectbeheersing), maar Ruben is niet op de hoogte van de actuele ontwikkelingen.
     - Mogelijke risicostrategien: referentie van mogelijke 'risk responses': https://www.stakeholdermap.com/risk/risk-responses.html

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

26-11-2021 – Online via MS Teams

Er zijn nog enkele toenames van RISMAN score die nog niet zijn verklaard. Voor het onderzoek is het van belang om deze redenen te achterhalen.

1. RI-021
   1.1. Toename in voortgangsrapportage: 0 [vooroverleg 4]
   1.2. Reden van toename
      - Dit risico is opgetreden met een hogere impact dan verwacht. Na gunning konden we verder onderzoeken en bleek de kwaliteit van de damwand niet in orde

2. RI-022
   2.1. Toename in voortgangsrapportage: 0 [vooroverleg 4]
   2.2. Reden van toename
      - We dachten dat we de opdrachtgever wel zouden kunnen overtuigen van onze uitgangspunten voor het ontwerp dat we in de tender fase hebben gemaakt. Maar tijdens de gesprekken met OG bleek er geen beweging in te zitten. Kans van optreden nam toe waarna het risico daadwerkelijk is opgetreden.

3. RI-032
   3.1. Toename in voortgangsrapportage: 2
   3.2. Reden van toename
      - In die fase is er veel aan het ontwerp gewerkt (samen met omgeving via ontwerp ateliers), en zijn we erachtergekomen dat het werk groter was dan in eerst instantie verwacht, waardoor het werk langer zou duren, dus er een grotere kans van optreden van dit risico ontstaat. Het idee was om meteen te beginnen met deze werkzaamheden, maar door de grote hoeveelheid en nieuwe inzichten moest het doorgeschoven worden naar later in de planning. Dit zou de impact van het risico ook verhogen.

4. RIS-0178
   4.1. Toename in voortgangsrapportage: 2
   4.2. Reden van toename
      - Waarschijnlijk een administratief foutje. OF even een optimistisch momentje, maar die is in de daaropvolgende periode gecorrigeerd.

5. RIS-0331
   5.1. Toename in voortgangsrapportage: 29
   5.2. Reden van toename
      - Gesprekken met bedrijf Kersten, waarin zij aangaven dat het veel werk is om het perceel klaar te maken voor werkzaamheden (inrit verplaatsen). Daaruit is geconcludeerd dat de plannign zou uitlopen als zij hun inrit niet op tijd zouden kunnen verplaatsen. Daarnaast bleek er ook nog geen deal te zijn gemaakt voor het overkopen (taak van OG)

   5.3. Toename in voortgangsrapportage: 36
   5.4. Reden van toename
      - Risico werd steeds kritischer omdat we dichter bij de deadline kwamen. Daarnaast hadden we er geen vertrouwen in dat de gemaakte afspraken nagekomen zouden worden

Interview met Procesmanager Gebiedsontwikkeling Ooijen-Wanssum

Ruben van der Zanden

26-11-2021 – Online via MS Teams

6. RIS-0425
   6.1. Toename in voortgangsrapportage: 40
   6.2. Reden van toename
      - Rest RISMAN was niet hoger dan initieel RISMAN bij identificatie (zoals grafiek wel suggereerd), maar was pas zichtbaar bij een hogere RISMAN score in de voortgangsrapportages. Verder is dit een risico dat later is aangemaakt en onderdeel is van een eerder genoemd container risico (hoogwater). Pas wanneer het risico zou gaan optreden, werd en container risico opgesplitst in kleinere risico's, om zo locatiespecifieke maatregelen te kunnen treffen. Door goede afspraken met omgeving en OG is het opgetreden risico correctief beheerst: het is opgetreden (mijlpaal 1 april klaar zijn is niet gehaald), maar de gevolgen zijn beheerst, omdat er instemming is met omgeving en OG.