An integrated risk management process that leads to a successful infrastructure project:

A case study of Heijmans

D.J.H.O. op het Veld
Master thesis
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TUDelft

heijmans

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Colophon

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Acknowledgements

This thesis is the final part to complete the master Construction Management & Engineering at Delft University of Technology. This study is conducted in collaboration with the contractor Heijmans. During the Christmas holidays in December I started to search for a feasible thesis in which I was eager to learn more about. While diving deeper into the repository of the TU Delft, I immediately wanted to focus on risk management and/or cost reduction within projects. Ideally, good risk management mitigates the negative impacts, and, therefore, reduces costs. From the end of April, I started the graduation journey and up to the end I was enthusiastic about risk management. This topic was my motivation to work hard and learn more about it. Risk management is a process that can always be improved and/or can never go perfect. Therefore, I wanted to dive deeper into this topic and contribute to science and practice of risk processes.

Although this thesis is conducted individually, I received a lot of help and support from my supervisors, Heijmans, friends and family. Therefore, I want to thank those people who kept me constantly motivated, focused, those who brought me teas during the day, wine in the evening and spent time with me to relax in the weekend.

First, the supervisors, who kept me motivated and focused. Every meeting with the graduation committee was very valuable. Marcel Hertogh, who started making things visually at the beginning and made sure the TU Delft and Heijmans were aligned in their thoughts about the thesis. Bertien Broekhans, who gave me a lot of insights in writing a thesis, focus on detail and was specific in appointing the areas that needed more attention. Erfan Hoseini, who gave me guidance every week and gave comments and critical feedback on how to conduct a research, why certain steps were made, gave me the focus to make progress every week and gave me the confidence I needed in this research. I appreciate the time involved in this thesis of all committee members. The progress and process of this thesis was not experienced so positive without this enormous strong team of supervisors.

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Third, I would like to thank my friends. Who were always positive about my work, kept me motivated and always interested in my research. The people that gave me tea during the day and wine in the evening. Although the graduation process was lonely, I want to thank their presence during supper and weekends.

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Dyonne op het Veld

Delft, November 2017

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Executive Summary

Introduction

This research is about improving the risk management process during the design phase. The need for this research is based on the difference between how risk management ideally should be performed in theory and how it is performed in practice. Risks are defined as the probability of occurrence times the impact of an event. Risks that are not managed properly could result in a negative impact on the project economics, such as cost overruns and time delays. Risk management is a method that aims to reduce the impact, associated with these risks. It ideally should be integrated within the project management approach to achieve this aim. However, several factors are involved in project management that influence correctly implementing and conducting risk management. The objective of this thesis research is to identify these factors that influence implementing and conducting risk management in practice and answers the main question:

'How can the risk management process be improved in such a way that the risks are controlled in a more preventive way in large infrastructure projects?'

Research approach

This research consists of four phases, shown in the vertical gray boxes in Figure 1. In addition, four researches are conducted in this thesis. First, a literature study to identify the essential steps that have to be included in risk management processes *(1) Part A: an Evaluation Framework*. Second, a case study which can be divided into a desk-research *(2) Part B: guideline of Heijmans* and a field research *(3) Part C: risk management in practice*. The study in Part B analyses how risk management ideally should be performed at Heijmans. Part C is a study to identify the factors that have a positive or negative influence on risk management in practice. In the end, these parts are compared and the differences between Part A, B, and C are identified to discuss, conclude, and recommend how risk management can be improved in large infrastructure projects. An overview of this process is given in Figure 1.
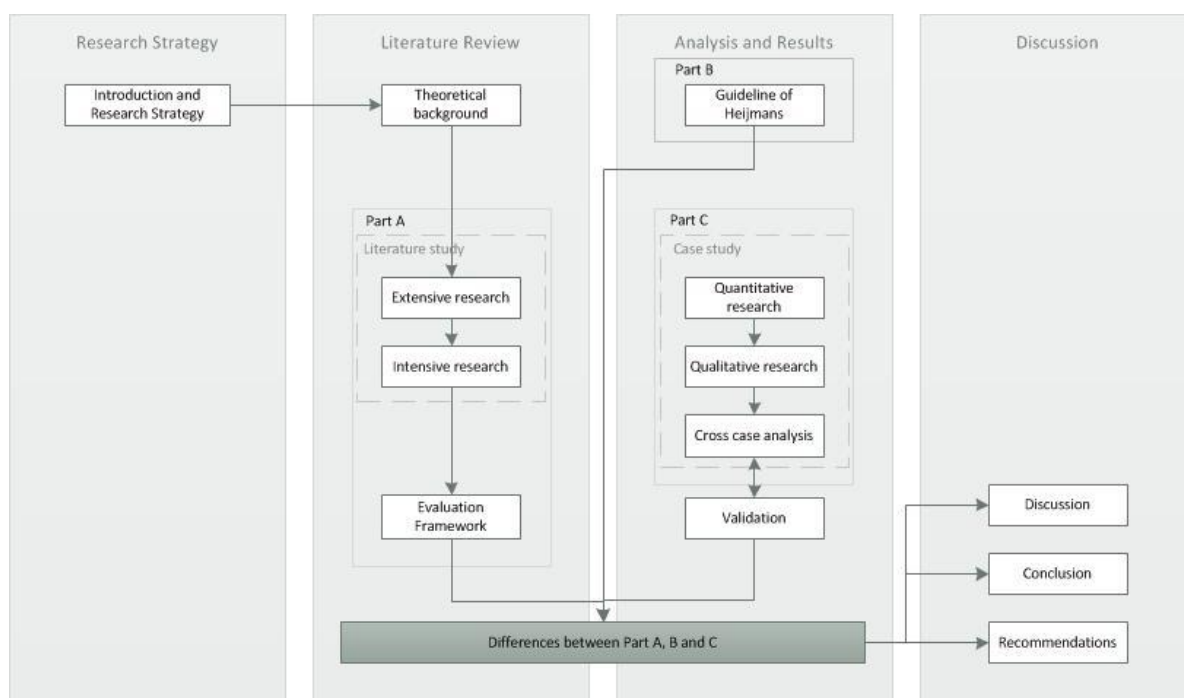

Figure 1. Overview thesis structure.

Part A: Evaluation Framework

Part A consists of a literature study (performed in phase II) to existing risk management standards and consists of an extensive and intensive research. The Evaluation Framework is created to easily compare the theory with the guideline of Heijmans. At present, Heijmans uses the RISMAN standard as a guideline for their own process, but the sufficiency of this standard cannot be assumed and therefore, it cannot be compared to the guideline of Heijmans individually. For this reason, the critical elements of different standards are included in this research.

What are the important steps in a risk management process?

A research is conducted that has the aim to make a first selection of thirteen risk management standards. The selection of these thirteen risk management standards are based on earlier studies of Raz and Hillson (2005) and Hoseini (2017) and include the standards: PRINCE2, ISO31000, COSO, IEEE Standard 1540-2001, PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA and IRM, IEC 62198:2013, PRAM, BS6079-3:2000 and ATOM. These standards were examined on the criteria 'project-based', 'definition', 'uniqueness', 'sector', and 'emphasis'. These criteria are defined to guard the alignment of the study. Which resulted in eight risk management standards that are applicable for this study. These standards are: PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA and IRM, IEC 62198:2013, PRAM, BS6079-3:2000 and ATOM. These standards are studied intensively based on the criteria: the 'level of detail', 'terminology', 'planning category', 'risk identification, analysis and treatment' and 'risk control'. Resulting from these criteria, the essential elements for the Evaluation Framework were defined. This Evaluation Framework contains elements that are essential within risk management procedures to perform a well-integrated risk management process. The four main elements: context, risk identification, risk assessment and risk response should be included in the Evaluation Framework and conducted as an iterative process. The Evaluation Framework is presented in Figure 2.
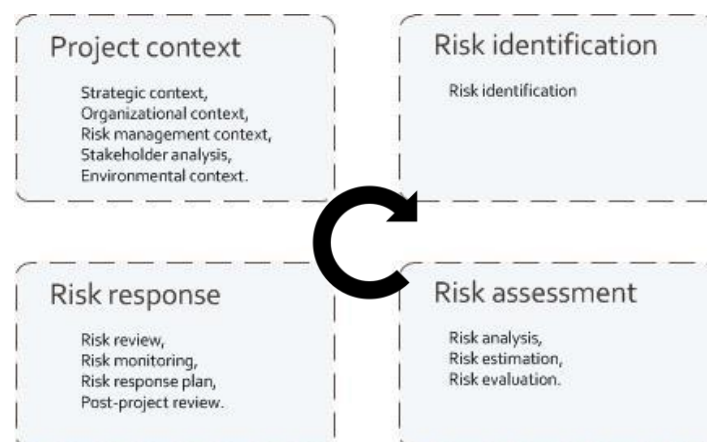

Figure 2. Evaluation Framework

Part B: Guideline of Heijmans

Part B consists of a desk-research to the guideline designed at Heijmans and is, together with Part C, part of the case study. The information is gathered by documents located on the online platform of Heijmans. The guideline consists of seven main-steps in which every main step consists of sub-steps. The main steps are: creating a risk management plan, identification of risks, quantification of risks, determine control measures, implement control measures, evaluate effective control measures, and monitoring the process.
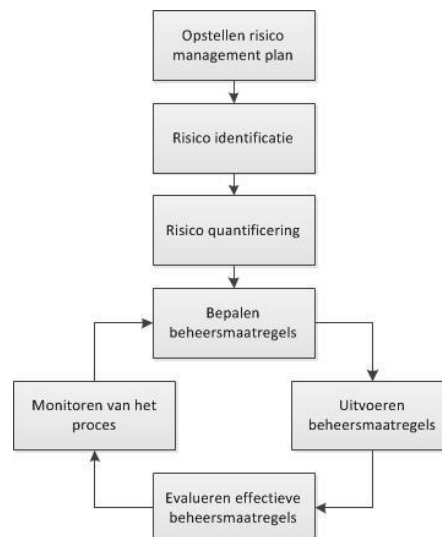
Figure 3. Guideline of Heijmans (Heijmans, 2017).

What are the differences between the Heijmans guideline and the Evaluation Framework?

The guideline of Heijmans is compared with the Evaluation Framework to identify the first differences that could influence the risk management performance. The found differences are:

- *Larger level of detail of the guideline of Heijmans*. This level of detail in the guideline of Heijmans is larger than the level of detail in the Evaluation Framework. The large level of detail gives better insights on what should be performed in which step. However, if the question is asked, does it also provide better insight? It might be that only risk managers and people highly involved in the process understand the process. For project team members that are not highly involved in this process, the guideline seemed to be too descriptive. This is based on a lack SMART defined sub-steps and descriptions of these steps.

- *A lot of attention is paid to the control measures in the iterative process of the guideline of Heijmans.* It is beneficial to consider control measures and treat the risks sufficiently. However, since three of the seven steps in their process are related to control measures, it might be unbalanced with the risk analysis part.

- *Insufficient implementation of context in the guideline of Heijmans*. A part of the context is considered in the risk management plan. It seems that only the contract documents and the client are considered in which the risk management plan is a document to confirm the risk management actions to the management team. In contrast, some of these steps are conducted by other managers, for example, the environment manager. Or already conducted in the tender phase, for example, the stakeholder analysis. However, it is important to conduct, for example, the stakeholder analyses during the whole project span due to the dynamic environment in which stakeholders can change as well.

- *The shortcoming in post-project review in the guideline of Heijmans*. The post-project review is neither mentioned. The post-project review is about capturing and recording the lessons learned for future projects.

- *Risk evaluation is not clearly considered in the guideline of Heijmans*. No attention is paid to the risk evaluation in the guideline of Heijmans. Within the risk assessment part, is seems that only risk quantification is considered.

Part C: Risk management in practice

Part C is part of the case study and includes a field-research that consists of a quantitative- and a qualitative research, and a cross-case analysis. The quantitative research is based on the Generic Risk Maturity Model (GRMM) designed by Hoseini (2017). The respondents of nine interviews filled in this model in which the output presents the risk maturity level in the current situation at Heijmans. Three 'één ontwikkelproces' projects are selected to evaluate and per project, two respondents participated. The other three respondents are part of non- 'één ontwikkelproces' projects. The selection of these three large infrastructure projects is based on a new project management process to reduce risks up front: the 'één ontwikkelproces' method. This method has the aim to identify and control risks up front to align decisions at the beginning of the project and considers the disciplines design, construct, and maintenance/asset. The qualitative research is based on the explanations of the respondents. In which additional questions were asked what the reason was for a low or high ranking of certain statements. In the end, a cross-case analysis of the quantitative and qualitative data of the respondents is conducted. The findings of Part C are validated by three experts at Heijmans.

Within the quantitative research, the risk maturity level consists of two levels: aspect level and statement level. All respondents had to fill in 51 statements, divided into 6 aspects: 'Policy & Strategy', 'Top management commitment', 'Culture & Personnel knowledge', 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review'. The scores of the statements determine the risk maturity level in a certain aspect.

To what extent is the risk management carried out in practice?
From quantitative analysis became clear that 'Policy & Strategy' and 'Risk Assessment' are the most mature aspects, which are related to the well-designed processes and systems of risk management. The ´Risk Assessment´ aspect has the smallest delta and is, therefore, more reliable. The aspect 'Culture & Personnel knowledge' was one of the two less mature aspects of all interviewees. The other less mature aspect differs per project between the aspects 'Top management commitment', ´Risk Treatment´ and 'Monitor & Review'. In contrast to the projects, the non- 'één ontwikkelproces' projects presented the aspect 'Policy & Strategy' as immature aspect besides 'Culture & Personnel knowledge'. From these results, it can be concluded that the 'Culture & Personnel knowledge' is most immature and reliable due to the small delta of the aspect.

The qualitative data is gained for factors that have a negative influence on the risk management performance to identify improvement areas. Figure 4 shows the factors that have a negative influence on risk management performance according to the respondents. The left grey box shows the factors on an abstract level. The right grey box shows the factors in a more detailed level. The blue boxes in the detailed level show the factors that have the largest influence on risk management performance validated by three experts. These four factors are: (1) busy with own complex tasks, (2) risk management is seen as an additional tool, (3) unclear process and (4) shortcoming in ownership.
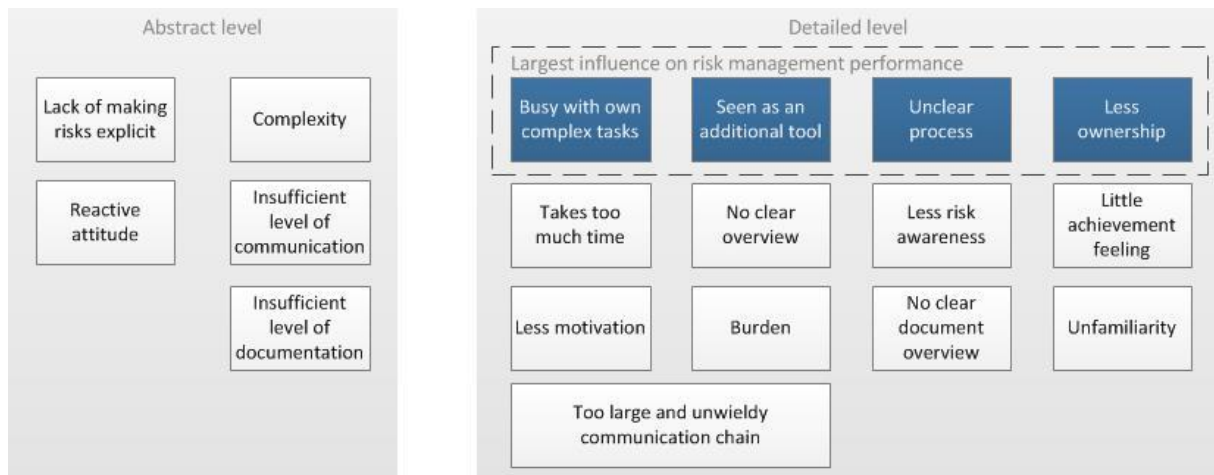
Figure 4. Findings qualitative data.

What are the differences between the Heijmans guideline and the risk management in practice?
The guideline of Heijmans is compared to risk management in practice. This resulted in four main difference on process level:

- *Inconsistent approach on discussing risks in management sessions in practice*. From the qualitative data, it is concluded that there is a shortcoming of implementing risks in the management sessions. The guideline describes that risks should be part of the management sessions. This was validated by experts as described in the guideline but confirmed that implementation of this element is project specific.
- *Insufficient instructing project team members in practice.* Within the quantitative data, receiving trainings to improve risk management skills and communication of goals and strategies were both ranked low.
- *In practice, the communication and documentation are low in maturity*. This is confirmed by the low level of risk maturity of the 'Monitor & Review' aspect with respect to the documentation. Moreover, the communication component presented an overall low maturity.
- *The risk control plan is not aligned with other risk maturity levels in practice*. In the guideline, more attention was paid to the risk control part. However, in practice, more attention is paid to risk identification, risk quantification and defining control measures. Regarding the guideline, control measures and their evaluation should be recorded within the online platform. In practice, no fulfillment is given to this risk control. The implementation of control measures is mainly based on judgement and experience, not based on strategies. In addition, no continuation is given to the evaluation of control measures after implementation.

Conclusion and recommendations
Based on the quantitative and qualitative data, a discussion arises on how risk management could be improved. Since the number of respondents is limited and the diversity is limited, a tentative conclusion is formulated. This conclusion has to be examined in further research.

How can the risk management process be improved in such a way that the risks are controlled in a more preventive way in large infrastructure projects?

Three different results appeared regarding improving the risk management process, see Figure 5. First, the result of implementing process steps in the guideline of Heijmans. The differences between Part A and B are based on the design of processes and relevant process steps. The results of these differences are based

on three findings that should be implemented within Heijmans to make the process as complete as possible: more fulfillment to the context, post-project review and risk evaluation.

Second, the mature risk maturity level of the processes. From quantitative and qualitative research resulted the positive, mature level of the process and system.

Third, the factors that could have a negative influence on the risk management performance. The differences between the guideline of Heijmans and risk management in practice resulted in four findings that should receive more attention. Those four findings are related to the quality of risk management performance.
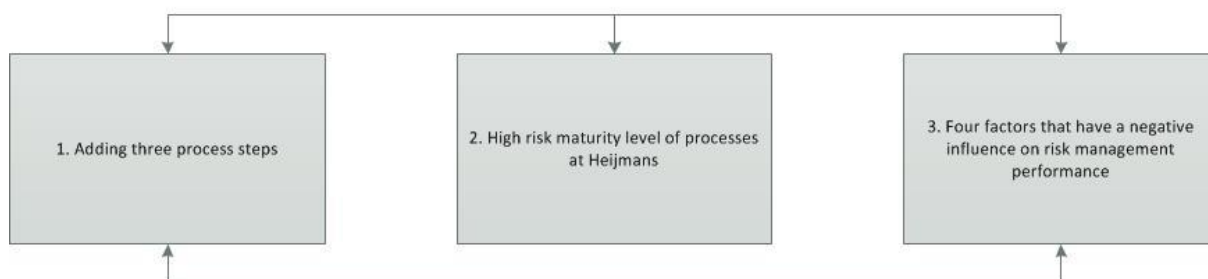

Figure 5. Overview three main findings.

Therefore, three discussion arises. First, a discussion based on the first and second result: an implementation of process steps, but is it necessary to implement these findings while the risk maturity level is mature? It seems that there is no need in practice to enlarge this process and adding those steps might not improve the risk management process.

Second, a discussion based on the second and third result: a mature level in the aspects related to the processes, however, the quality of performance states other factors that have a negative influence on the risk management performance. This discussion is especially important for Heijmans, since Heijmans pays a lot of attention to the improvement of the processes. The performance is mainly part of the lower layers within the project. From quantitative and qualitative data resulted the need for a clearer process which takes less time and is not experienced as a burden. At present, people are unfamiliar with the process and it is experienced as unclear. This seems contradictory to the need of adding steps in the process. This result appoints the need to dive deeper into the risk management processes as performed in practice and the experienced negative influence on the risk management performance.

Finally, a discussion based on the first and third result: is it important to implement or clarify the process? At present, a lot of attention is paid on the improvement of the risk management process at Heijmans. However, the study to risk management in practice appointed the need to improve the factors that influence the quality of performance instead of improving risk management at a top management level. Therefore, it is likely that more attention should be paid to what is asked in practice. A balance should be created between what is asked from the lower layers and what is a preferable process according top management level.

These three results on how to improve risk management are not validated in this study. Therefore, additional research should be conducted on how the risk management can be improved to make it a more integrated part with project management in large infrastructure projects. It is necessary to dive deeper into these results to find the root-causes of the factors that influence risk management. The recommendations for further research, Heijmans and the model are formulated.

Heijmans:
- A process is more than following standards and guidelines. To pay more attention to the performance of risk management and the layer in which risk management is performed, processes can be made clearer and less abstract. The whole organization will be familiar with the process.
- Focus on the aspects, statements, and qualitative results that could influence risk management in practice to improve the performance of risk management. This will result in a better integration. However, additional research is necessary to transfer these identified problems into feasible improvements for the organization.

For the used Generic Risk Maturity Model:
- Specify the list of statements per field of activity per company
- Change the scores
- Implementing a system or guideline area beside the organizational and applicational areas.

Further research:
- Conducting this research in other companies and/or other projects to gain a solid conclusion for improving the risk management process. The sample will be larger and a more valid conclusion can be drawn.
- Include more interviewees to gain a larger diversity of respondents that results in more valid results. In this research, only the design manager and risk manager is included. To make sure the drawn conclusion is valid, respondents of lower levels must be included.

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Samenvatting

Introductie

In deze thesis is onderzocht hoe het risico management proces kan worden verbeterd in de ontwerpfase. De motivatie van dit onderzoek is het verschil in hoe risico management volgens de theorie zou moeten worden uitgevoerd en hoe het in de praktijk wordt uitgevoerd in grote infrastructurele projecten. Risico's worden bepaald door de mogelijkheid van optreden vermenigvuldigd met de impact. Waarbij de impact invloed heeft op de project economie, zoals kostenoverschrijdingen en vertraging(en) in de planning. Risico management is een methode dat tot doel heeft de impact te reduceren. Wetenschappers stellen dat risico management moet worden geïntegreerd in het project management proces om het reduceren van de impact zo goed mogelijk te bereiken. Echter, verschillende factoren kunnen deze implementatie beïnvloeden. Het doel van het onderzoek is om deze factoren te identificeren die het succesvol doorvoeren van risico management in project management belemmeren door de volgende onderzoeksvraag te beantwoorden:

> 'Hoe kan het risico management proces worden verbeterd zodat risico's aan de voorkant van grote infrastructurele projecten al worden beheerst?'

Onderzoeksstrategie

Dit onderzoek bestaat uit vier verschillende fases, weergegeven in de grijze verticale blokken in Figure 6. Om de onderzoeksvraag volledig te kunnen beantwoorden hebben vier onderzoeken plaats gevonden. Allereerst is er door middel van een literatuurstudie onderzoek gedaan naar de risico management standaarden om de essentiële stappen in risico management te identificeren; Deel A: Evaluatie Framework. Vervolgens heeft er een case study plaats gevonden die onder te verdelen is in een desk-research; Deel B: handboek van Heijmans, en een fieldresearch; Deel C: risico management proces in de praktijk. Deel B focust zich op hoe het risico management proces is omschreven bij Heijmans. Deel C focust zich op hoe de vertaalslag van risico management processen wordt gemaakt in de praktijk en wat de factoren zijn die een positief of negatief effect hebben op het uitvoeren van risico management. Tot slot zijn deze delen met elkaar vergeleken om de verschillen te identificeren en vervolgens tot een conclusie te komen over hoe het risico management proces kan worden verbeterd. Dit hele proces is weergegeven in Figure 6.
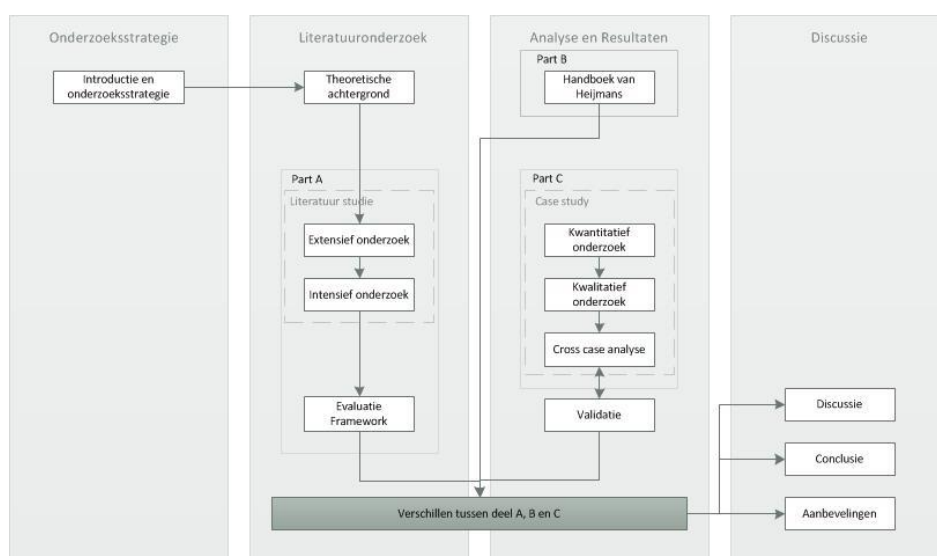

Figure 6. Overzicht thesis structuur

Deel A: Evaluatie Framework

Deel A omvat een literatuurstudie (beschreven in fase II) die bestaat uit een extensief en intensief onderzoek om vervolgens een Evaluatie Framework te creëren. Het Evaluatie Framework heeft ten doel om de kritische elementen, beschreven in risico management standaarden uit de literatuur, te vergelijken met het proces omschreven bij Heijmans. Op dit moment gebruikt Heijmans de RISMAN standaard als leidraad voor hun eigen proces, maar er kan niet worden gesteld dat deze RISMAN standaard voldoende volledig is om individueel het Heijmans proces te toetsen. Om deze reden zijn de kritische elementen van verschillende standaarden meegenomen in het onderzoek. Het Evaluatie Framework is gecreëerd om de theorie gemakkelijk met de andere twee delen in deze thesis te vergelijken.

Wat zijn de essentiële stappen in een risico management proces?

Het extensief onderzoek heeft ten doel om een eerste selectie te maken van dertien risico management standaarden. Deze dertien risico management standaarden zijn geselecteerd op basis van een eerder onderzoek van Raz en Hillson (2005) en Hoseini (2017). Deze standaarden zijn: PRINCE2, ISO31000, COSO, IEEE Standard 1540-2001, PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA en IRM, IEC 62198:2013, PRAM, BS6079-3:2000 en ATOM. Binnen het extensief onderzoek zijn de standaarden op een abstract niveau getoetst aan de hand van de volgende criteria: 'organisatie of project gerelateerd', 'definitie', 'uniekheid', 'sector', en 'nadruk'. Deze criteria zijn opgesteld zodat de standaarden binnen de scope van deze thesis vallen. Dit resulteert in een selectie van acht risico management standaarden die intensief worden onderzocht: PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA en IRM, IEC 62198:2013, PRAM, BS6079-3:2000 en ATOM. Deze toetsing is gedaan aan de hand van de volgende criteria: level of detail, terminologie, planning fase, elementen in de identificatie, analyse en behandeling en vervolgens risico controle. Dit heeft uiteindelijk geleid tot een selectie van essentiële elementen die in een risico management proces zouden moeten zitten en weergegeven in een Evaluatie Framework, zie Figure 7. Deze essentiële elementen zijn van belang om een goed geïntegreerd risico management proces uit te voeren. De vier elementen zijn: project context, risico identificatie, risico beoordeling en risico response en vormen een iteratief proces.
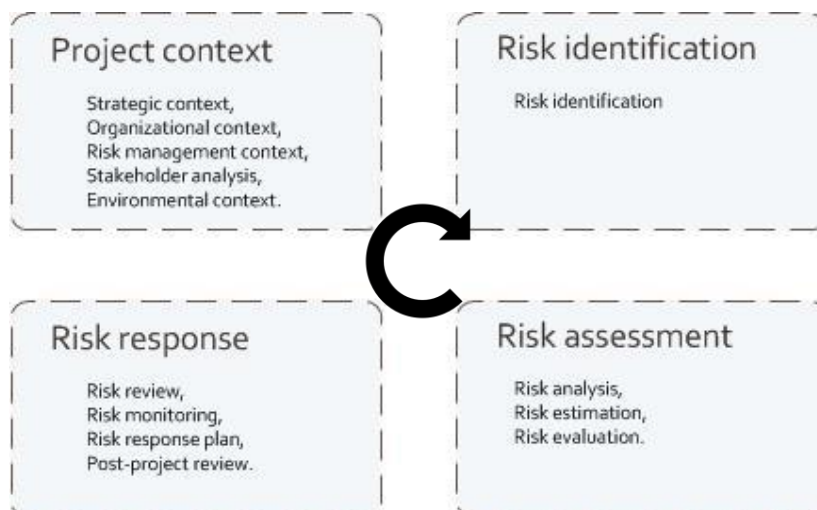

Figure 7. Evaluatie Framework

Deel B: Handboek van Heijmans

Deel B is uitgevoerd aan de hand van een deskresearch naar het handboek van Heijmans als onderdeel van de case study. Deze informatie is verkregen via documenten op het online platform van Heijmans. Het

handboek bestaat uit zeven hoofdstappen waarvan elke stap sub stappen bevat. De hoofdstappen zijn weergegeven in Figure 8.
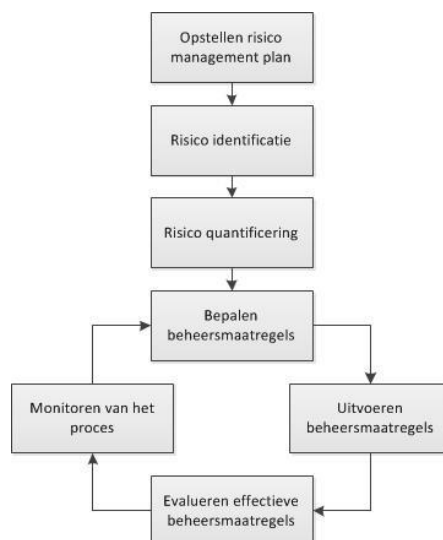

Figure 8. Handboek van Heijmans (Heijmans, 2017).

Wat zijn de verschillen tussen het handboek van Heijmans en het Evaluatie Framework?

Het handboek van Heijmans is vergeleken met het Evaluatie Framework om zo de eerste verschillen te identificeren die invloed kunnen hebben op het uitvoeren van het risico management proces. Deze verschillen zijn:

- *Het handboek van Heijmans is gedetailleerd omschreven en geeft aandacht aan kleine details*. Het gedetailleerd omschreven handboek geeft meer inzichten in wat er per stap verwacht wordt in vergelijking met het abstract omschreven Evaluatie Framework. Hoewel deze details duidelijk zijn voor risico managers en betrokken personen bij risico management, kan het voor buitenstaanders abstract overkomen. Het is beschrijvend omschreven en niet SMART. Dit kan leiden tot problemen voor team leden die het handboek raadplegen.
- *Daarnaast besteedt het handboek meer aandacht aan de beheersmaatregelen dan aan risico identificatie en kwantificatie*. Dit kan zorgen voor een onevenwichtige balans. Drie van de zeven stappen zijn aan beheersmaatregelen besteed, terwijl het Evaluatie Framework er één stap aan wijdt.
- *Gebrek aan invulling van de context in het handboek van Heijmans*. Een deel van de context wordt meegenomen in het handboek van Heijmans. Op dit moment wordt voornamelijk het contract en de opdrachtgever meegenomen in de context. Daarnaast zit de stakeholder analyse in de tenderfase verwerkt, maar het is van belang om dit gedurende het hele proces door te voeren. Ook zit er een omgevingsmanager in het project team, deze omgevingsmanager zorgt voor de vorderingen in de omgevingscontext waardoor deze stap wel in het project wordt uitgevoerd, maar geen onderdeel is van het risico management proces.
- *Gebrek aan meenemen van geleerde lessen in het handboek van Heijmans.* Dit onderdeel is niet genoemd in het handboek van Heijmans en gaat over het waarborgen en opnemen van geleerde lessen voor toekomstige projecten.
- *Risico evaluatie komt niet duidelijk naar voren*. In het handboek van Heijmans wordt er geen aandacht besteed aan de risico evaluatie. Binnen het risk assessment gedeelte wordt er voornamelijk aandacht besteed aan de risico kwantificering.

Deel C: Risico management in de praktijk

Risico management in de praktijk is onderdeel van de case study en betreft een fieldresearch die bestaat uit een kwantitatief en kwalitatief onderzoek en cross case analyses. Het kwantitatieve onderzoek is gebaseerd op het Generic Risk Maturity Model (GRMM) ontworpen door Hoseini (2017). De respondenten van negen interviews hebben dit model ingevuld met als uitkomst het huidige risico volwassenheidsniveau bij Heijmans. Drie projecten zijn geselecteerd om te evalueren en per project zijn twee respondenten geïnterviewd. De drie andere respondenten zijn medewerkers die niet betrokken zijn geweest bij de 'één ontwikkelproces' projecten. De keuze om projecten met een 'één ontwikkelproces' methode te analyseren is gemaakt omdat deze methode risico's al aan de voorkant signaleert. Dit wordt gedaan zodat de drie disciplines ontwerp, constructie en beheer en onderhoud al aan de voorkant van een project met elkaar om tafel gaan zitten. Op deze manier kunnen de drie disciplines al aan de voorkant keuzes met elkaar afstemmen. Het kwalitatief onderzoek is gebaseerd op uitleg van statements van de respondenten waarbij er gevraagd werd waarom bepaalde statements laag of hoog scoorden. Vervolgens is er door middel van cross case analyses een patroon onderzocht tussen de verschillende projecten, rollen en projectsoorten. De bevindingen van de uitkomsten van Deel C zijn gevalideerd door 3 experts.

In welke mate is het risico management proces uitgevoerd in de praktijk?

De kwantitatieve data tonen resultaten op twee levels: aspect level en statement level. In dit model zijn door elke geïnterviewde 51 statements ingevuld, verdeeld onder 6 aspecten: 'Policy & Strategy', 'Top management commitment', 'Culture & Personnel knowledge', 'Risk Assessment', 'Risk Treatment' en 'Monitor & Review'. De scores voor de statements in een bepaald aspect bepalen het volwassenheidsniveau van dat aspect. Uit de kwantitatieve analyse is gebleken dat de aspecten 'Policy & Strategy' en 'Risk Assessment' het meest volwassen zijn. Deze aspecten zijn gerelateerd aan de goed ontworpen en volwassen processen en systemen. Het aspect 'Risk Assessment' toont de laagste delta, dat resulteert in een betrouwbaardere uitkomst. Het aspect 'Culture & Personnel knowledge' is in elk project, rol en projectsoort als één van de twee minst volwassen aspecten naar voren gekomen. Ook dit aspect had een kleine delta dat resulteert in een betrouwbaarder resultaat. Het andere aspect verschilde per project en wisselde tussen de aspecten 'Top management commitment' en 'Monitor & Review' in de projecten. Contrasterend is het aspect 'Policy & Strategy' dat bij de niet- 'één ontwikkelproces' projecten als minst volwassen aspect naar boven kwam. Bij de risico managers was dit het aspect 'Risk Treatment'.

Het kwalitatief onderzoek focust voornamelijk op de elementen die een negatief effect hebben op het uitvoeren van risico management aangezien het doel is om het proces te verbeteren. Deze elementen zijn weergegeven in Figure 9. De vier mogelijke oorzaken weergegeven in donkerblauw, geven de zwaarstwegende invloeden in projecten weer en zijn belangrijk om als eerste aan te pakken. Deze oorzaken zijn: druk met eigen complexe taken, het risico management wordt vaak gezien als een bijkomende tool, het proces kan als onduidelijk worden ervaren en gebrek aan eigenaarschap bij project team leden.
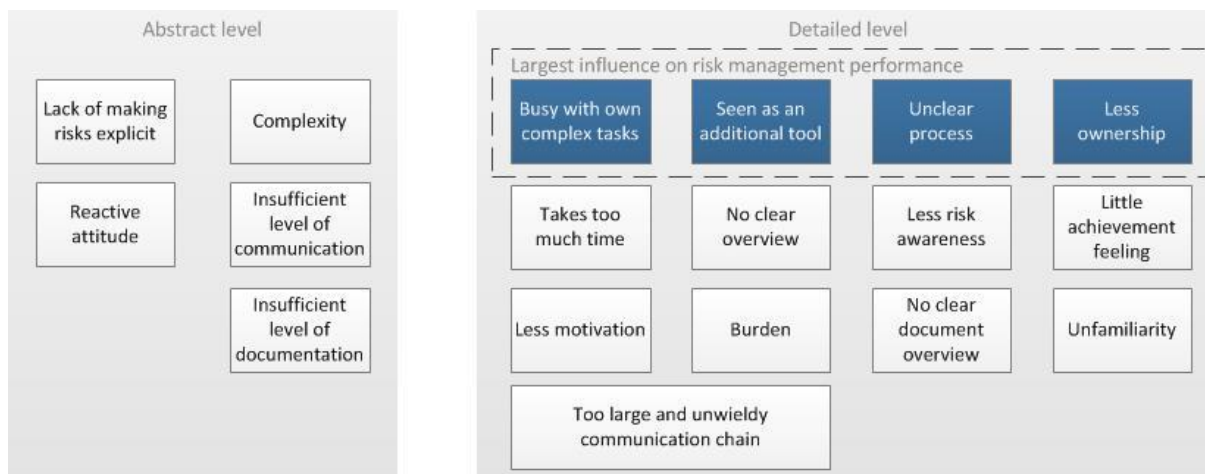
Figure 9. Bevindingen kwalitatieve analyse.

Wat zijn de verschillen tussen het handboek van Heijmans en risico management in de praktijk?

Het handboek van Heijmans is vergeleken met de bevindingen van risico management in de praktijk. Dit resulteerde in vier hoofdverschillen op proces niveau.

- *Inconsistent behandelen van risico's in het kernteam overleg*. In het handboek van Heijmans is omschreven dat risico's onderdeel moeten zijn van kernteam overleggen. Maar uit kwalitatief onderzoek is gebleken dat dit bij een aantal projecten niet wordt gedaan. Hierbij werd aangegeven dat het positief zou werken als de risico manager onderdeel zou zijn van vaste risico management overleggen.
- *Tekort aan instrueren van projectteam leden*. Uit kwantitatief onderzoek bleek dat de statements 'Er is een training om de risico management skills te verbeteren' en 'de doelen en strategieën zijn gecommuniceerd' een lage score hebben. Daarnaast kwam het nergens meer terug in de onderzoeken.
- *Communicatie en documentatie zijn niet voldoende volwassen in de praktijk*. Communicatie (en documentatie) is een component dat door de verschillende aspecten heen kruist. Uit kwantitatief onderzoek is gebleken dat communicatie lager scoort in volwassenheid dan andere statements. Hoewel er veel aandacht wordt besteed aan het monitoren van het proces, lijkt de communicatie en documentatie in de uitvoering achter te lopen.
- *Risico beheersmaatregelen zijn niet op één volwassenheidsniveau met andere proces stappen.* Zoals beschreven wordt er in het handboek veel aandacht besteed aan risico beheersmaatregelen maar in de praktijk wordt hier minder aandacht aan gegeven. 'Risk Treatment' komt regelmatig als laag scorend aspect naar voren en in Relatics is te zien dat er uiteindelijk geen evaluatie is van de beheersmaatregel. In de praktijk lijkt er meer aandacht voor de identificatie en kwantificering te zijn.

Conclusie en aanbevelingen

Uit kwantitatieve en kwalitatieve data volgt een discussie over hoe risico management zou kunnen worden verbeterd. Aangezien het aantal respondenten gelimiteerd is en de diversiteit beperkt is, is er een voorlopige conclusie geformuleerd. Deze conclusie zou in verder onderzoek nog moeten worden onderzocht.

'Hoe kan het risico management proces worden verbeterd zodat risico's aan de voorkant van grote infrastructurele projecten al worden beheerst?'

Uit dit onderzoek komen drie resultaten naar voren, zie Figure 10. Allereerst, het verschil tussen het Evaluatie Framework en het handboek van Heijmans waarbij naar voren kwam dat stappen zouden moeten worden toegevoegd aan het handboek van Heijmans. De verschillen tussen het Evaluatie Framework en het handboek van Heijmans is gebaseerd op het ontwerp van de processen en relevante proces stappen. De resultaten van deze verschillen zijn gebaseerd op drie bevindingen die kunnen worden geïmplementeerd om het proces zo compleet mogelijk te maken: meer invulling in de context, eerdere geleerde lessen meenemen en risico evaluatie.

Vervolgens kwam het hoge volwassenheidsniveau naar boven in de praktijk. Uit kwantitatief en kwalitatief onderzoek resulteerde een positief en volwassen niveau van het proces en het systeem.

Tot slot, het verschil tussen het handboek van Heijmans en risico management in de praktijk dat resulteerde in vier bevindingen die meer aandacht zouden moeten krijgen. Deze bevindingen zijn voornamelijk gerelateerd aan de kwaliteit van het uitvoeren van risico management.
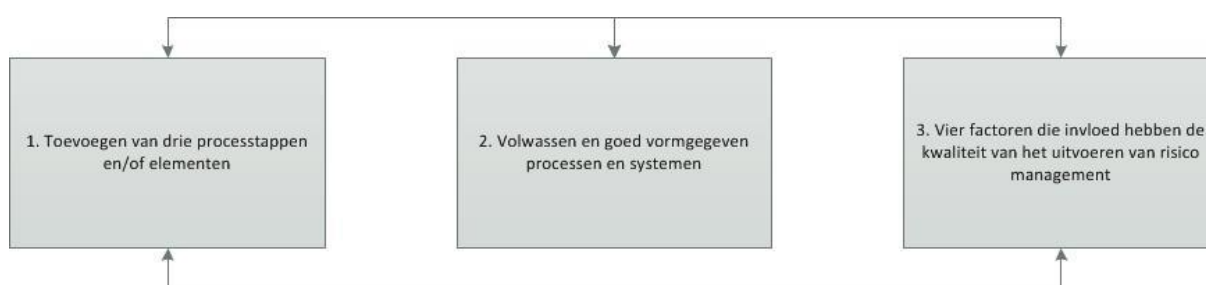

Figure 10. Overzicht drie hoofdbevindingen.

Gebaseerd op deze resultaten kunnen drie discussies worden gevoerd. Allereerst het verschil tussen het eerste resultaat en het tweede resultaat: het toevoegen van stappen en het volwassen niveau van de processen in Heijmans. Enerzijds, lijkt het erop dat de verschillen tussen de onderdelen zouden moeten worden toegevoegd aan het bestaande proces. Anderzijds, zijn de processen en systemen, ontworpen op top management niveau, volwassen. Hierdoor lijkt het erop dat er geen noodzaak is om het proces te verbeteren, het toevoegen van stappen zou het proces niet kunnen verbeteren.

Ten tweede, de discussie gebaseerd op het tweede en derde resultaat: het volwassen procesniveau en de factoren die een negatief effect hebben op risico management in de praktijk. Het concreet uitvoeren en toepassen van risico management wordt voornamelijk door de lagere levels in de project hiërarchie gedaan. Kwantitatieve en kwalitatieve data laat de noodzaak voor een duidelijker proces dat minder tijd kost en niet ervaren wordt als een last zien. Momenteel zijn projectteam leden niet eigen met het proces en wordt het ervaren als onduidelijk.

Tot slot, het verschil tussen het eerste en derde resultaat: het toevoegen van stappen en de factoren die invloed hebben op de uitvoering in de praktijk. Op dit moment wordt er veel aandacht besteed aan het verbeteren van het risico management proces bij Heijmans. Hoewel uit onderzoek in de praktijk is gebleken dat de meeste problemen ontstaan in de uitvoering van risico management. Daarom lijkt het erop dat meer aandacht zou moeten worden besteed aan de uit de praktijk geïdentificeerde factoren die het uitvoeren van risico management belemmeren. Er zou een balans moeten worden gezocht tussen wat er gevraagd wordt vanuit de lagere lagen en wat een prettig proces is.

De drie resultaten om het risico management in de praktijk te verbeteren is niet gevalideerd in dit onderzoek. Daarom is het van belang om aanvullend onderzoek uit te voeren naar hoe het risico management kan worden verbeterd om het een geïntegreerd deel te maken van project management in grote infrastructurele werken. Het is van belang om dieper in detail te treden om zo de kern oorzaken te

vinden dat risico management beïnvloed. De aanbevelingen voor aanvullend onderzoek, voor Heijmans en het model zijn onderstaand geformuleerd.

<u>Heijmans:</u>
- Een proces is meer dan het volgen van de BPS documenten. Door meer aandacht te besteden aan de uitvoering kunnen processen ontstaan die voor iedereen in de projectorganisatie begrijpend en behapbaar zijn.
- Focus op de aspecten, statements en kwalitatieve oorzaken die in dit onderzoek naar voren zijn gekomen. Met name in de uitvoering om zo een beter geïntegreerd risico management proces te creëren.

<u>Model:</u>
- Specificeer de lijst van statements per sector of activiteit per bedrijf.
- Andere keuze voor score. Deze scores resulteren in grote delta's dat verwarring kan opleveren.
- Implementeren van een systeem of guideline area, naast de organization- and application area.

<u>Aanvullend onderzoek:</u>
- Onderzoek in andere of meer projecten en/of bedrijven om zo een meer betrouwbaar resultaat te presenteren
- Onderzoek met meer respondenten met verschillende projectrollen waardoor meer verschillende inzichten worden verkregen op hoe het risico management is uitgevoerd in de praktijk en waar de oorzaken liggen. Met name onderzoek in de lagere lagen van een projectorganisatie om zo de voorlopige conclusie te onderzoeken en eventueel te valideren.

Content

List of abbreviations and terms

Abbreviation	In words	Author
CO	Conceptual design	
VO	Temporary design	
DO	Final design	
UO	Executive design	
DM	Design manager	
RM	Risk manager	
PMP	Project management process	
GRMM	Generic Risk Maturity Model	
CSF	Critical Success Factors	
SMART	Specific, Measurable, Agreed upon, Realistic, Time-based	
KPI	Key Performance Indicator	

Terms	In words	Author
Risk	An implication of significant uncertainty which may be upside (welcome) or downside (unwelcome)	(Chapman & Ward, 1997)
Uncertainty management	The ability to prophesy outcomes of parameters or foresee events that may affect the project	(Moavenzadeh, 2009)
Opportunity management	A continuous process to identify, analyze and follow up uncertainties which can lead to positive impacts on the project by implementing response actions to benefit from the opportunities	(Moavenzadeh, 2009)
Risk management	A continuous process to identify, analyze and follow up uncertainties which can lead to negative impacts on the project by implementing response actions to avoid risks jeopardizing a successful completion of the project	(Moavenzadeh, 2009)
Consortium	An association, typically of several firms	(Oxford, 2017)

Table 1. List of abbreviations and terms.

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PHASE I – Research Strategy

PHASE I – Research Strategy explains the basics of this thesis. Chapter 1 elaborates on the introduction, problem, and motivation. Chapter 2 elaborates on the research question, sub questions, thesis outline and methodology.

1. Introduction

Within projects, there are a lot of elements that change. Change leads to uncertainty, and as a result, risks appear. A lot of projects fail due to uncertainty and risks. Especially complex projects are more vulnerable to risks (Hertogh & Westerveld, 2010). Complex projects are seen as large projects with long time schedules, multi-ownership, involving substantial resources, significant political issues and significant novelty (Chapman & Ward, 1997). The root causes of project related risks are mostly part of the organizational dynamics and multidisciplinary nature of the business´ organization (Thamhain, 2013). For this reason, risk management becomes important, which is especially crucial in technology-based projects. Risk management must be seen as an ongoing review process in the whole Project Life Cycle (Thamhain, 2013). Chapman and Ward (1997) stated already in 1997 that risk management must be a core process within the strategic management of any business or organization. No matter the size, the activity, or the sector.

Risk management has the aim to reduce risks (Nicholas & Steyn, 2012). Widely, a lot of research is performed to risk management standards. These standards give hands on managing risks and are mostly described in an abstract way as it must be applicable to all projects. The general risk management standards that are defined in literature are implemented in all mature risk management organizations in extreme complex projects to manage risks (Caño & Cruz, 2002). Risk management is a process that should be integrated within project management (Nicholas & Steyn, 2012; Zou, Chen, & Chan, 2010). It is widely recognized by leading project management institutions that risk management should be an integral part of the project management (Caño & Cruz, 2002). While making risk management an integral part of project management, it is necessary that risk management must be adopted by the project management approach. Risk management is not just a management tool that can be added besides the project management but it must be part of the project management (Chapman and Ward, 1997).

1.1. Problem definition

A lot of research is dedicated to risk management. Often, the way it is performed is not in the way it was initially planned. Chapman and Ward (1997) stated that there is a gap between good practice in theory and good practice as experienced. This is related to a broad range of causes. According to Project management Institute (2013), risk conditions may include aspects of the project's or organization's environment that contribute to project risks, such as immature project management practices, lack of integrated management systems, concurrent multiple projects, or dependency on external participants who are outside the project's direct control. Managing project risks are often based on experience, and all these parties have different experience, knowledge, perceptions, objectives and learned another way to deal with risk (Chapman & Ward, 1997).

At Heijmans, infrastructure projects have a cost overrun of 4.7%, which have a significant negative impact on the project economics. In addition, time delays play a crucial role within infrastructure projects. For infrastructure projects, these negative impacts are mostly identified before the construction phase. Risk management is a process that should control and manage these negative impacts on a project. When risk management is used, it is important to use it in the best possible way. As mentioned in the previous paragraph, risk management must be an integral part of project management and could not directly be

implemented in the project management process. To reduce risks and to deliver a project in a manageable way, Heijmans implemented a new project management process in the design phase of projects from 2015. In this process, the design, construction, and maintenance/asset part are highly integrated with each other in the phases Conceptual Design (CO), Temporary Design (VO), Final Design (DO) and Executive Design (UO). In this way, risks should be managed up front.

At present, there are three projects in construction with this new process: 'één ontwikkelproces' (See Appendix A). In this thesis, these projects are described as 'één ontwikkelproces' projects. Currently, risk management is not a well-integrated part of this project management process. However, this was one of the main purpose(s) of implementing the project management plan. This identified gap leads to the motivation for this research.

1.2. Research objective

The research objective is to improve the risk management process that is conducted in 'één ontwikkelproces' projects by identifying the factors that influence the quality of risk management performance. This is done by evaluating 'één ontwikkelproces' projects of Heijmans. Identifying the differences between theory and practice, insights are given which could lead to more controllable infrastructure projects in a contractor's organization. As a result, a discussion and conclusion about possible improvements are given based on identified differences and factors.

2. Research Strategy

Chapter 2 elaborates the design for this graduation thesis. Based on this design, the stated problem should be tackled. First, Section 2.1. elaborates on the thesis outline that includes the main and sub-questions. Second, Section 2.2. presents the scope of this research. Finally, Section 2.3. elaborates on the methods used to aim the answer to these questions.

To determine which source is relevant for gathering information the following questions of Verschuren and Doorewaard (2010) are considered. "*What are the main categories of research objects that can be distinguished?*", "*What types of information on these objects are relevant to the research project, and how can this information be identified?*" and "*Where this information can be gathered or how can it be generated?*". The outcome of the source is explained in Section 2.3.

2.1. Main questions and sub-questions

This study is divided in three different parts, where each part is covering a (range of) question(s). The first question is based on literature. The last two questions are based on a case study. In which the following main question is overlapping:

How can the risk management process be improved in such a way that the risks are controlled in a more preventive way in large infrastructure projects?

Part A: **What are the important steps in a risk management process?**

    a. What are the general differences between the risk management standards?
    b. What are the common steps of risk management standards?

Part B: **What are the differences between the Heijmans guideline and the Evaluation Framework?**

Part C: **To what extent is the risk management carried out in practice?**

    a. What is the current risk maturity situation at Heijmans?
    b. What are the differences between the Heijmans guideline and the risk management in practice?

2.2. Scope of this research

This research focusses on the risk management processes in the design phase of large infrastructure projects. In which factors are identified that can have an influence on the performance of risk management.

- The focus is on the risk management process at an abstract process level. Risk management can be performed at two levels: on process and on element level. Within this research, the focus is on risks at the process level. These risk management processes are based on risk management standards from theory.
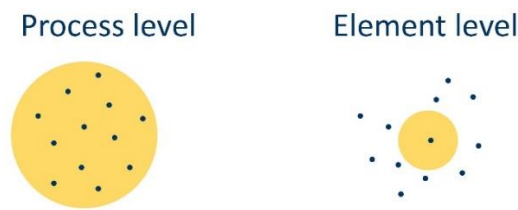
Figure 2.1. Process and element level.

- The focus is on the design phase. As explained in Chapter 1, Heijmans makes uses of a new project management process: 'één ontwikkelproces'. This process is performed in the design phase of projects. To evaluate this process, it is necessary to focus on the design phase.
- The large infrastructure projects is based on the high complexity involved in these projects, the alignment with the Master Construction Management & Engineering and two of the three pilot projects of the 'één ontwikkelproces' are large infrastructure projects.
- The study focusses on differences between theory, the guideline of Heijmans and practice. To focus on the differences, factors can be identified that have an influence on risk management.

2.3. Methodology

This section describes the methodology that is used in this thesis. This research consists of four studies. First, a literature study of part A. Second, a desk research to part B. Third, a descriptive case study of part C. Fourth, the differences between those three parts based on a deductive comparison (Verschuren & Doorewaard, 2010). The study to part A, B and C is performed in series. While the comparison between those parts is performed in parallel (See Figure 2.2). Part A is based on extensive and intensive literature study, and Part B and Part C on an intensive descriptive case study. However, Part B is based on an intensive desk research. Due to the gather information which is already described by Heijmans and not conducted by the author themselves (Swanborn, 2010; Verschuren & Doorewaard, 2010). The research in Part C deals with several elements in practice that must be considered in this study. A case study is a good research manner when many more variables of interest are included in the collected information (Verschuren & Doorewaard, 2010; Yin, 2014). This case study is based on field research in which quantitative and qualitative data is gained from interviews. These two types of data collection are considered as there is an essential common ground (Yin, 2014).
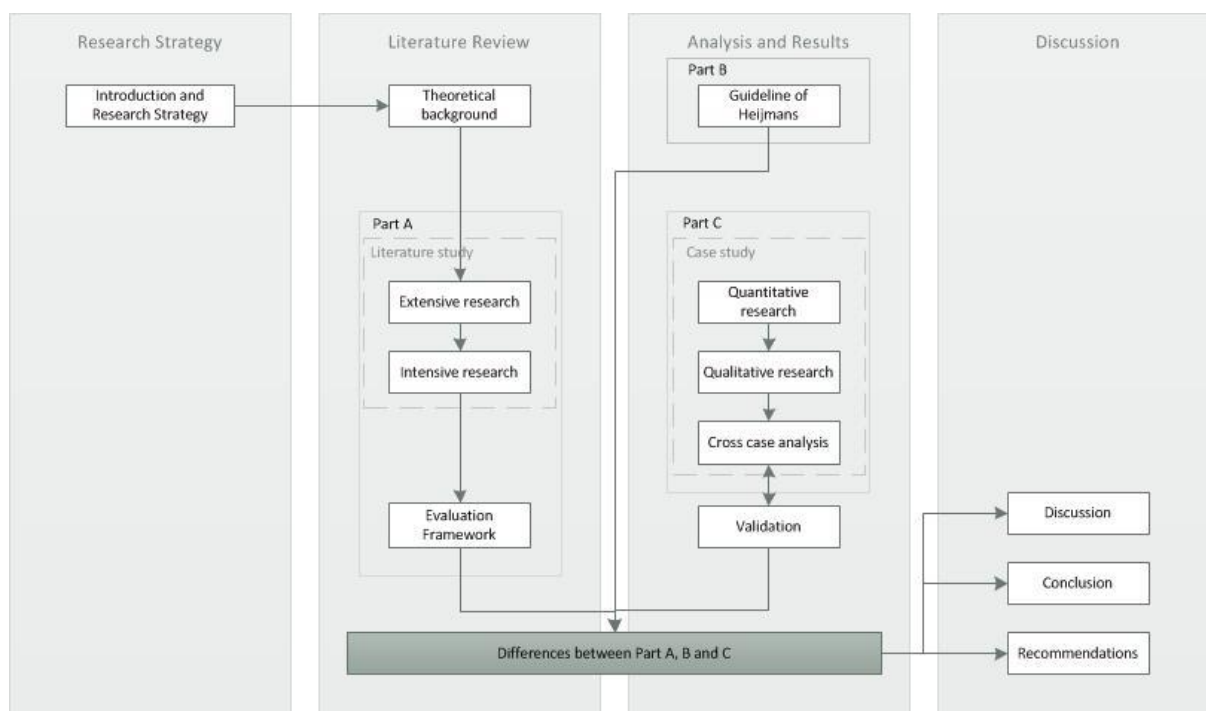
Figure 2.2. Thesis outline.

Part A: Evaluation framework.

Part A, the purpose of creating an Evaluation Framework is to generate a clear overview of common steps in risk management standards as explained in literature. The goal of this research, and therefore the creation of the Evaluation Framework, is to easily compare the standards with the guideline of Heijmans and risk management in practice. This framework is based on extensive and intensive literature research. It is necessary to first do a literature study that contains relevant information when a research is carried out (Verschuren & Doorewaard, 2010). The relevant literature already written and examined about risks is used as a knowledge source for further research in this thesis. The extensive research is performed to create external validity (Swanborn, 2010). The extensive research examines 13 risk management standards, formulated based on earlier studies of Raz and Hillson (2005) and Hoseini (2017). In addition, intensive research is performed to diverge the gathered information to create an Evaluation Framework. The eight risk management standards, resulted from the extensive research, will be analyzed thoroughly by an intensive research to create the Evaluation Framework. This study is conducted in Chapter 4.

Part B: Guideline of Heijmans.

Part B is the guideline of Heijmans. This guideline is created by Heijmans. The Generic Risk Maturity Model (GRMM) is used for the data analysis of risk management in practice and is based on literature. The GRMM determines the level of which risk management is conducted in practice. This model is based on twelve Best Practices, thirteen Risk Maturity Models and five articles about the best-practices and tested and evaluated by focused groups (Hoseini, 2017a). These bricks are used to analyze the completeness of the Heijmans guideline. The aim is to compare the essential elements of the risk management standards with the Heijmans guideline. In this way, it can be determined what the differences are and possible factors that could influence the risk management performance. This analysis is conducted in Chapter 5.

Part C: Risk management in practice.

The Generic Risk Maturity Model (GRMM) is used to analyze the risk management process in practice. The Generic Risk Maturity Model, as designed by Hoseini (2017) is used to determine in which extent risk

management is currently performed. The interviewees were asked to fill the model. The model provides quantitative results. The output of this model is quantitative data and qualitative data. The quantitative data is the direct output of the model and shows the level of maturity of risk management according respondents. Defining the level of maturity can contribute to cost reduction and improving profitability (Zou et al., 2010). The qualitative data is gained based on additional in-depth questions asked while filling in the GRMM. This quantitative and qualitative data is analyzed in Chapter 6 and is highly important as risk management maturity can identify the areas needing improvement (Zou et al., 2010).

Comparison between the parts.

The fourth study in this thesis is based on deductive comparison between the three parts (A, B, and C). The relation between those parts is shown in Figure 2.3. First, the Evaluation Framework is compared with the guideline of Heijmans. Second, the guideline of Heijmans is compared with risk management in practice. Since a domino effect is created by comparing A and B, and B and C, an additional comparison between A and C results in same differences. Therefore, this comparison is not included.
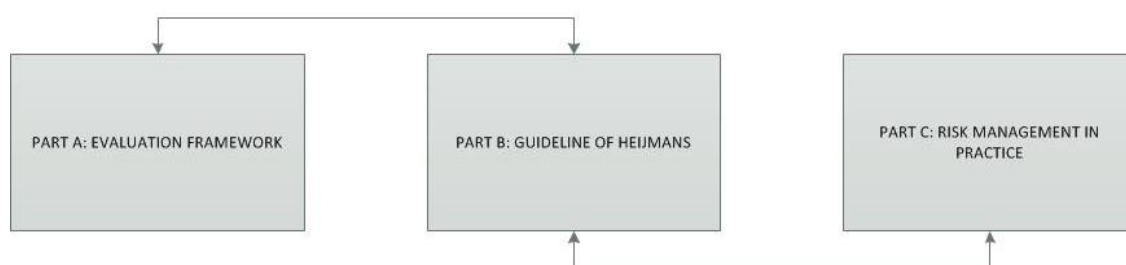
Figure 2.3. Comparison relation between Part A, B, and C.

2.3.1. Selection of interviewees

The selection of the experts that are interviewed in this thesis is mostly based on the three 'één ontwikkelproces' projects. These projects are elaborated in Appendix B. As mentioned in the introduction, these three projects are part of a pilot project at Heijmans at which they use a new design process to execute projects: 'één ontwikkelproces'. To make sure that the results can be compared in a comprehensive way, for every project a risk manager (RM) and a design manager (DM) is interviewed. The reason to choose a risk manager is that of his/her role as a facilitator of the risk processes within a project. The choice for a design manager is based on their role as a team member and mostly part of the management team (except the design coordinator). They are often the risk owner and key communicator between the (design) project team and the risk manager.

All the interviewees have a work experience of more than 3 years at Heijmans and were part of several projects in the past. Therefore, their opinion and thoughts about the maturity of the risk management approach are useful. The primary aim is to retrieve new information about the differences in the way project risk management is applied at Heijmans. In total 9 interviews took place which is divided into roughly two categories. The first category, the project group, which consisted of six project staff, of which two per project. The second category referred as a general group, which consisted of a general risk manager and two general design managers (See Table 2.1).

The general interviewees are included since they provide different insights about the way project risk management is conducted in general. In addition, their data is used to compare with the 'één ontwikkelproces' project to see which strategy works better related to risk management processes and where the approach in general projects works better or worse than in 'één ontwikkelproces' projects.

The risk manager of Project X has a combined role as a risk manager and System Engineer and is employed at Heijmans. The risk manager of Project Y and the risk manager of Project Z are both full-time focused on risk management. Both risk managers of Project Y and Project Z are employed at a consortium firm. The consortium firm works together with Heijmans in total three projects. The general risk manager is employed at Heijmans and has never worked together with the consortium firm at a project. Which makes it a good mix of risk managers to investigate in this research. The design managers are all employed at Heijmans.

Interviewee	Project	Role	Type of projects	Interview date
1	Project X	Risk manager - System Engineer	Infrastructure, sewage treatment	12-07-2017
2	Project X	Design coordinator	Infrastructure, sewage treatment	12-07-2017
3	Project Y	Business manager	Road infrastructure	11-07-2017
4	Project Y	Design leader	Road infrastructure	01-08-2017
5	Project Z	Risk manager	Road infrastructure	09-08-2017
6	Project Z	Integral design Manager	Road infrastructure	10-07-2017
7	General	Risk manager	Infrastructure	02-08-2017
8	General	Design	Infrastructure	10-07-2017
9	General	Design	Infrastructure	13-07-2017

Table 2.1. List of interviewees.

2.4. Introduction to the Generic Risk Maturity Model

The Generic Risk Maturity Model (GRMM) is used to structure the interviews and make it easier to compare all the different data of the interviews. A Risk Maturity Model measures the extent in which risk management is implemented in an organization and/or project (Hoseini, 2017a). By asking the interviewees to give a certain score for the level of implementation to the statements, the outcomes can be easily compared. In this way, a comparison is made between the maturity of the projects. The interviewees had not seen the statements before the interview, which causes a spontaneous judgement.

This model of Hoseini is chosen since it includes an extensive investigation of twelve risk management standards, thirteen Risk Maturity Models, and five best practices and is evaluated in the practice. Hoseini's aim is to identify the mature and immature aspects of risk management. In this thesis, this model is used to determine the immature aspects of Heijmans.

Two areas are divided in the model: the 'organizational area' and the 'application and process area'. Every area includes three aspects. For the organizational area: 'Policy & Strategy', 'Culture & Personnel knowledge', 'Top management commitment'. For the application and process area: 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review'. In total, 51 statements are included in the model. These statements are divided into six aspects as shown in Figure 2.4.
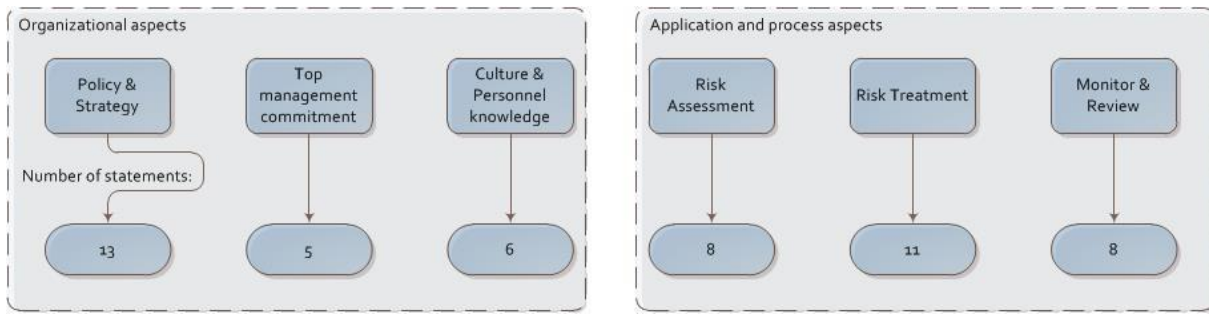
Figure 2.4. Overview of the aspects and their statements of the Risk Maturity Model.

To measure the risk maturity of a project, the participants filled in the extent in which the statement is implemented in the project in the first column. Besides, they decided the importance of each statement in their projects by scoring in the third column. Also, the interviewees are asked to score the ambition level in the fourth column (See Figure 2.5).

Figure 2.5. Overview of the form as part of the Risk Maturity Model (Hoseini, 2017a).

For all columns, the following scores must be filled in 0, 3, 7 and 10. 0: not applied, 3: limited applied, 7: applied to a large extent and 10: totally applied. The average score per aspect is calculated by the following formula (Hoseini, 2017a):

$$N = \sum_{i=1}^{j} Importance_i \qquad \textit{(Equation 1)}$$

$$Total\ score = \sum_{i=1}^{j} Score_i \times \frac{importance_i}{N} \qquad \textit{(Equation 2)}$$

To ensure the interviewees appointed the improvement area(s), 7 open-questions are asked in addition as part of the qualitative analysis. All the interviewees answered general questions which are shown in Appendix D. If the statements already appointed the improvement areas (score of 0 or 3), additional questions are asked to gain more knowledge about the background of the statement. Finally, the quantitative data is combined with the qualitative data.

2.4.1. Description generating data priority

The formula that is designed to determine the priority areas is based on the parameters: scores, importance, and ambition. In contrast to the current situation, all statements are considered. In this formula, the ambition is multiplied by the importance, minus the score times the importance. The following formula is used to determine the priority per statement:

$$(ambition * importance) - (score * importance) = Score\ of\ priority$$

$$A * I - R * I = P \qquad \qquad \text{(Equation 3)}$$

In which:

R: Score of risk maturity
A: Ambition (the extent of implementation how they would see it in the future)
I: Importance
P: Priority score

Ambition times *importance* is the number which shows the desired level of risk management according to the interviewees. The *score* times *importance* shows the current maturity of risk management. By subtracting these amounts, a difference occurs. The larger the difference, the higher the level of priority. To determine which aspect has the highest priority, the following formula is used. The sum of the outcome of equation 3 of all statements per aspects is divided by the number of statements per aspect. The formula is:

$$Total\ score = \frac{\sum_{i=1}^{j} P_i}{N} \qquad \qquad \text{(Equation 4)}$$

In which:

P: Priority   score
N: Amount of statements

To determine where the project should be in the future, the ambition is an essential parameter.

The differences between aspects and statements can be calculated in several ways. Another way in which it can be calculated is when the different outcomes receive a new weight. For example, the possible outcomes of equation 3 are 0, 9, 21, 28, 30, 40, 49, 70 and 100. By giving these outcomes a new weight, the aspects of improvement can be calculated by adding all the new weights per aspect and divide it by the amount of statements per aspect in which an average is created. Nonetheless, equation 3 and 4 are easy to understand and use, therefore this formula is a leading formula regarding calculating the statements prior to improvement in this thesis.

PHASE II – Literature Review

This phase provides an answer to the question: '*What are the important steps in a risk management process?'*. Phase II is based on literature. Chapter 3 gives the theoretical background of risks and project risk management that is relevant for further research and understanding the terms *risk* and *(project) risk management* in this thesis. Chapter 4 dives deeper into the risk management standards and investigates the most important elements of all standards to create an Evaluation Framework.

3. Theoretical background of project risk management

Chapter 3 provides insight into the theory behind risks and risk management based on available literature. It elaborates on the context of risk management based on theory. The formulated subjects are the theoretical background of the definition of risks, the history of risks, project risk management, types of risks and the successful elements of risk management in project management.

3.1. Context of project risk management

Figure 3.1. History of Project management.
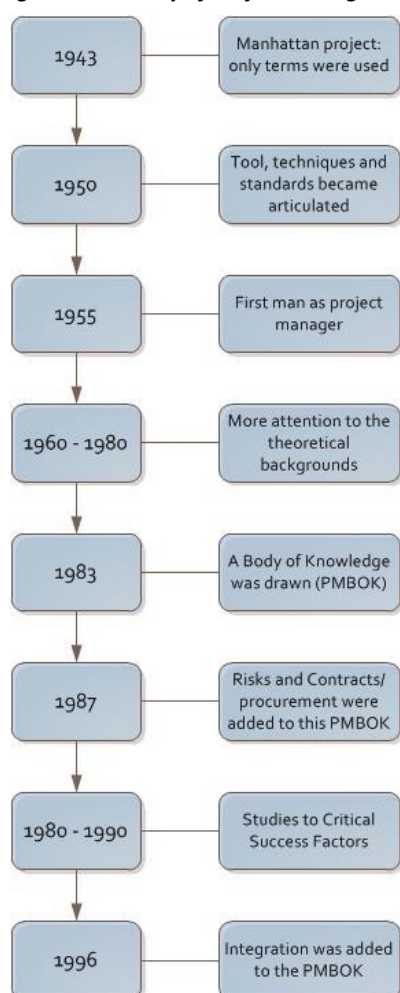
Since the start of life, projects are already there. Prehistoric hunting was a well-managed project-based activity. However, during that time, these activities were not yet organized with a pre-defined project management approach. Many argue, that within the first usage of project management only terms were used. Tools, techniques, and standards became articulated post the early to mid-1950s (See Figure 3.1) (Morris, 2013). From the late 1960s to the mid-1980s more attention came to the theoretical grounds on "why" one would need "how much" project integration of organizational units and "when" (Morris, 2013). Prior studies showed the essential elements project management defined in the Iron Triangle and includes quality, costs, and time (See figure 3.2). In 1983, a ´body of knowledge´ was drawn up to give a brief explanation of project management. This Body of Knowledge (BOK) proposed six knowledge areas as "unique to the project management field" (Project Management Institute, 2013): Scope, Time, Cost, Quality, Human Resources, and Communications. In 1987 the Project management Institute added Risks and Contracts/Procurement to this Body of Knowledge (See Figure 3.3). In 1996, a revision added integration to the knowledge areas and changed the document's name into ´*A Guide to the Project management Body of Knowledge´ (PMBOK Guide). Nowadays still known as the PMBOK standard* and consists of thirteen processes. The knowledge areas still form the basis for this Project Management Body of Knowledge (Project Management Institute, 2013). All these elements in project management should receive the same attention within projects. These elements focus on the implementation process and activities. Risks and uncertainties are mostly high during the pre-implementation phase (Jaafari, 2001).
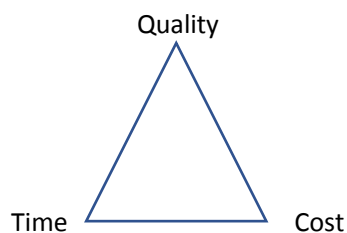
Figure 3.2. Iron Triangle (Albert, Balve, & Spang, 2017).

The importance of risk management became more clear since project management became a more familiar term (Dionne, 2013; Harrington & Niehaus, 2003). Challenges of risk management within project management are good planning and managing future risks, all caused by decisions regarding project structures and design that are made at an early stage in the project lifecycle. In which modern risk management demands an interdisciplinary and trans-sectional approach (Klüppelberg, Straub, & Welpe, 2014).

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	■	■	■	■	■
5. Project Scope Management		■		■	
6. Project Schedule Management		■		■	
7. Project Cost Management		■		■	
8. Project Quality Management		■	■	■	
9. Project Resource Management		■	■	●	●
10. Project Communications Management		■	■	■	
11. Project Risk Management		■		■	
12. Project Procurement Management		■	■	■	■
13. Project Stakeholder Management	■	■	■	■	
14. Project Health, Safety, Security, and Environmental Management		●	●	●	
15. Project Financial Management		●		●	

■ PMBOK® Guide Knowledge Areas and Process Groups included in *Construction Extension*
● Construction-specific Knowledge Areas and Process Groups unique to *Construction Extension*

Figure 3.3. Knowledge areas of the Body of Knowledge (PMI, 2016).

In major infrastructure projects, failure of the before mentioned knowledge areas is common, mostly due to the uniqueness of the project (Beckers & Stegemann, 2013). Failure can be thought of as cost overruns, delays, failed procurement, or unavailability of private financing. According to Hertogh and Westerveld (2010), the biggest problems occur in the areas of time, budget and benefits, and stakeholder satisfaction (Hertogh & Westerveld, 2010). Especially complex projects are more vulnerable to risks in which the construction industries are subjected to greater risks and uncertainties than other industries (Shobana, Kumar, & Kumar, 2014). Hertogh and Westerveld (2010) mentioned how to manage the complexity. When the situation is uncertain, interaction is needed. When the situation is complex in detail, control is needed. The main finding

for managing complexity is that it is mostly outside the control of a project manager (Hertogh & Westerveld, 2010). Modern infrastructure projects are enormous complex (among other things due to the DBFM contracts (Hertogh & Westerveld, 2010)) which asks for a properly structured and delivered project. Due to the complexity, it is necessary to have a division of roles and responsibilities among specialized players (Beckers & Stegemann, 2013).

Probability and uncertainties grow when projects become more complex. Uncertainty will not necessarily diminish over time in complex projects with a changing environment (Jaafari, 2001; Sigmund & Radujkovic, 2014). Therefore, it is important to continuously sense the project variables, evaluate the status of the objective function, take action and re-adjust the project strategies (Jaafari, 2001). In which social elements are most dominant (Hertogh & Westerveld, 2010). Uncertainty functions can describe discrete events or continuous ranges of outcomes (Moavenzadeh, 2009). According to Miller and Lessard (2001), uncertainty applies to situations in which potential outcomes and causal forces are not fully understood. We refer to both as risks (Miller & Lessard, 2001). Currently, several different definitions of risks and uncertainty are being used (Moavenzadeh, 2009). Risk and Uncertainty management are highly related to each other. Uncertainty management contains risk management and opportunity management. The definitions are described on page xxiv and the relation is shown in Figure 3.4.
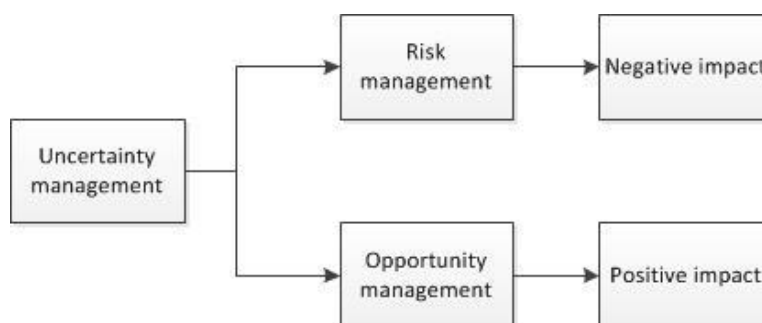
Figure 3.4. Relation uncertainty management and risk management.

Risk management is defined in order to mitigate the risks within a project (Nicholas & Steyn, 2012). Ideally, risk management should be an integral part of project management since the roots of risks are located in the project management approach (Nicholas & Steyn, 2012; Zou et al., 2010). The results of a certain project have an impact on the organization in several dimensions, therefore, it is relevant to conduct successful projects (Jugdev & Müller, 2005).

As stated before, in major infrastructure projects, failure occurs often due to the complexity of projects. Thamhain (2013) stated that mostly the root causes of project-related risks are part of the organizational dynamics and multidisciplinary nature of the business' organization. Therefore, risk management becomes important, which is especially crucial in technology-based projects. Risk management must be seen as an iterative, ongoing review process in the whole duration of the project (Thamhain, 2013).

Failure can also be caused by decisions that are made in an early stage of a project development (Beckers & Stegemann, 2013) which is in line with the dynamic complexity as stated by Hertogh and Westerveld. In one of the reports of Beckers and Stegemann (2013) is stated that `*A poorly designed project delivery approach or the wrong decisions about procurement can also lead to delays, higher costs, and diminished returns´* (Beckers & Stegemann, 2013). Also, Miller and Lessard (2001) stated that *'the seeds of success or failure are planted and nurtured as conscious choices are made'* (Miller & Lessard, 2001).

Often, the successfulness of a project is based on the aspects of the iron triangle, time cost and quality. In addition, Jugdev and Müller (2004) mentioned that project success is also owing to diving into other projects, looking to best practices and communicating with other projects (Jugdev & Müller, 2005). An extensive study of the critical success factors of projects is performed with a focus on how project managers think they are more effective at managing projects. Some elements that the project managers mentioned are based on making statements SMART[1].

3.2. Types of risks

Rumsfeld (2011) made a distinction between known and unknown. Figure 3.5 shows the known and unknown risks related to the mindset and knowledge. By analyzing and evaluating the process, these factors are a whole in which the whole risk management process is considered.

	Knowledge	Lack of knowledge
Open mind	Known known	Known unknown
Closed mind	Unknown known	Unknown unknown

Figure 3.5. Differentiation of risks between known and unknown (Meyer & Reniers, 2016).

The risks are divided into 4 different events by Rumsfeld (2011):

- First, there are known knowns: there are things we know we know (Rumsfeld, 2012). Or events that we know from the past and have an open mind towards(Meyer & Reniers, 2016).
- Second, there are known unknowns: that is to say we know there are some things [we know] we do not know (Rumsfeld, 2012). Or, stated by Meyer and Reniers (2016), events that we do not know from the past, but which we have an open mind towards.
- Third, Rumsfeld (2011) described unknown unknowns – the ones we don't know we don't know. Meyer and Reniers (2016) described these unknown unknowns as events that we do not know from the past (they have never occurred), and look at with a closed mind.
- The fourth is described by Meyer and Reniers (2016) as unknown knowns, these are events that we know from the past (we have certain information or records about them), and look at with a closed mind.

Known risks are those risks that can be controlled and managed in a pro-active way since they are identified and analyzed. If they cannot be controlled and managed in a proactive way, a contingency reserve is necessary as a response. According to Miller and Lessard (2001), risks should be mitigated with traditional risk management approaches when risks are endogenous (specific and controllable). Unknown risks are the risks that cannot be managed in a proactive way, therefore, a management reserve is necessary (Project Management Institute, 2013).

The definition Moavenzadeh (2009) is used in this report as a starting point: "*Risk management is a continuous process to identify, analyze and follow up uncertainties which can lead to negative impacts on the project by implementing response actions to avoid risks jeopardizing a successful completion of the*

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[1] SMART: S: specific, M: measurable, A: agreed upon, R: realistic and T: time-based.

project". The history of risks comes from the prehistory, but from the 1980s and 1990s, the terms became clearer and more and more research was carried out to investigate the roots of risks and how to control them.

3.3. Success factors in project risk management

Several researches to Risk Maturity Models concluded the successful elements that should be included within risk management. These successful elements include the general steps within risk management standards and other aspects, mainly based on lessons learned. These general steps within risk management standards are explained in Chapter 4. The other aspects are formulated in this section.

For these aspects, several different names have been mentioned in studies. The names of three different studies are shown as an example. First, the division in system, process, people, and culture based on the research of Zou et al. (2010). Second, culture, stakeholder coalition, leadership, risk management process, project management process and technology/system design (Yeo & Ren, 2009). Third, Hoseini (2017a), who divided these aspects into 'Policy & Strategy', 'Top management commitment', 'Culture & Personnel knowledge', 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review' (Hoseini, 2017a).

These aspects are divided into organizational and application areas (Hoseini, 2017a; Zou et al., 2010). In which the organizational aspects include top management, people, and leadership in implementing risk management which creates the organizational culture (Zou et al., 2010). This part is mainly based on the designed, predefined tools, techniques, and systems by senior management. The aspects 'Policy & Strategy', 'Top management commitment' and 'Culture & Personnel knowledge' are included in this area as they influence the organizational dynamics.

The application area consists of risk identification and risk treatment techniques and processes and is based on the implementation of these techniques and processes (Zou et al., 2010). This is in line with the elaborations of Hoseini (2017) who divided the aspects 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review' in this area. Since these three aspects determine the extent to what the processes, tools and techniques are implemented.

Underlying these aspects, several common risk factors and/or required capabilities are mentioned in researches. Within this thesis, as mentioned in Section 2.4., the common risk factors and/or required capabilities of Hoseini (2017) are used as he did an extensive literature research to these factors and capabilities. For this reason, his division of aspects will be elaborated in order to gain knowledge about these aspects for further research.

In addition, mostly every aspect contains factors related to communication. These factors are called statements in this thesis. This communication component contains 5 statements that are part of different aspects and different areas, see Figure 3.6. Communication is hard to divide into a separate aspect as it is an overarching domain. Communication is about monitoring and responding to risks; evaluation of options (Love, Fong, & Irani, 2005). In addition, it is involved in the 'Culture & Personnel knowledge' aspect since communication generates useful knowledge for achieving project, learning for future projects and for personal growth of individual project actors (Love et al., 2005).
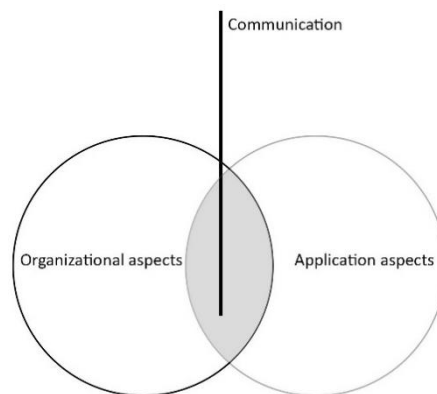
Figure 3.6. Relation communication component within aspects.

1. **Policy and strategy**

To maximize success, policies and strategies should be developed. By defining policies and strategies, risks can be minimized in a structured way since strategies are designed to identify risks and evaluate risks (Munier, 2014). The strategy within projects is an overarching component that implements a structure within all projects that are performed in parallel in an organization. Mostly, senior management has thought about these strategies and policies. This involves shared objectives, resources, or other issues within projects (Chapman & Ward, 1997). In a top-down approach, the higher management within an organization develops and implement these strategies in projects (Chapman & Ward, 1997).

In the used GRMM of Hoseini (2017), 'Policy & Strategy' is formulated as the level of integration of risk management process in project management, for example, by testing if goals are formulated and communicated to the project team, or if risk management objective(s) are aligned with the project management objective.

2. **Top management commitment**

Within contractor's organizations, project management is broken down into a hierarchical structure. In large engineering projects, projects are managed based on several components, running in parallel. In which the top management level of the construction project is the highest hierarchical layer. This top management level will not know all the details of the lower managements, however, they have to be committed within the project and should understand these details (Chapman, 1997).

In the model of Hoseini (2017), 'Top management commitment' aspect is formulated as the commitment of the management team with the risk management process. For example, if they communicate the goals and strategies of risk management process and if they encourage and support the risk management process within the project. Since commitment of top management has an effect on the persistent of risks of failure (Nicholas & Steyn, 2012).

3. **Culture & Personnel knowledge**

The definition of culture formulated by Hofstede (2001) is: "the collective programming of the mind that distinguishes the members of one group or category of people from another" (Hofstede, 2001). Another definition by Klukhohn (1951) is "Culture consists in patterned ways of thinking, feeling and reacting, acquired and transmitted mainly by symbols, constituting the distinctive achievements of human groups,

including their embodiments in artifacts; the essential core of culture consists of traditional ideas and especially their attached values" (Kluckhohn, 1951).

The culture within an organization is highly related to planning, control, and includes, as stated by Hofstede (2001, p.373); "corporate governance; motivation and compensation; leadership and the empowerment of subordinates; management development as well as organization development; and performance appraisal plus management by objectives". Within the culture of organizations, power distance and uncertainty avoidance are crucial (Hofstede, 2001). In which power distance includes responsibilities and ownership. While uncertainty avoidance includes the trust that what is expected from a person is performed, and is feeling-based.

'Culture & Personnel knowledge' is in this study a combined aspect. In which half of the statements focus on the culture and half of the statements on personnel knowledge. The culture is formulated to test the interrelations with project colleagues. For example, if they trust each other, if they are open/transparent, if they are risk aware, etc. The personnel knowledge focusses more on the experience of the people involved in project risk management. For example, if trainings are organized to improve the risk management skills. Nicholas & Steyn (2012) stated that risk a function is of the uniqueness of a project and the experience of the project team (p. 351). This appoints the necessity of including an experienced project team. The effect of the experience of a person can influence how risks are assessed. For example, risk managers with an experience are willing to avoid risks, while risk management with low experience often take risks.

4. Risk Assessment

Risk Assessment is in several standards described literature stated differently. Some include the risk identification and risk estimation within the risk assessment, others separate both elements as Schuyler (2001) did. Risk identification is identifying risks and determine what the consequence could be of this risk (Nicholas & Steyn, 2012; Schuyler, 2001). An extensive literature on the differences between these process steps are examined in Chapter 4.

The 'Risk Assessment' aspect is based on risk likelihood, risk impact and risk consequence. These factors have to be identified to determine if the risks and the consequence are significant for a certain project (Nicholas & Steyn, 2012). Well-stam et al. (2003) does not explicitly mention the Risk Assessment. Within their research, Risk Assessment is stated as identification of risks and determine the most important risks. However, indirectly, this determination is based on quantifications and significance of a project. The aim of Risk Assessment is to improve the control over a project in which it gives more insights in the factors that can influence the control aspects of projects (Well-Stam, Lindenaar, Kinderen, & Bunt, 2003). In addition, it helps to improve the priority determination, decision-making based on strategies and it gives a good bases for an estimation (Well-Stam et al., 2003). The risk identification is an input for the risk assessment (Schuyler, 2001) and should be performed continuously as the assessment of the beginning of the project is often not the same as at the end of a project phase (Bissonette, 2016). Which also leads to the importance of monitoring and actualizing the risk dossier, this monitoring and review will be explained later in this section.

In contrast to Schuyler, Hoseini (2017) combines risk identification and risk assessment and focusses mainly on the risk identification and quantification in the model. Most of the statements appoint in which the risks should be identified, quantified, a risk-owner should be chosen and the process should be performed based on the project risk management process.

5. Risk Treatment

The threshold determined in the Risk Assessment helps the Risk Treatment aspect with identifying which type of response is applicable for what risks (Bissonette, 2016). Risk Treatment is the aspect of performing risk management in a project. The main question 'What we do about the risks?' is leading in determining the risk response according Schuyler (2001). Often, the risks are mitigated, however, other strategies that could be applied are avoid, accept and transfer risks (Nicholas & Steyn, 2012). In the Risk Treatment aspects it is necessary to continually make risks explicit and control these risks, dealing with risks proactively and consider control measures (Well-Stam et al., 2003). These steps are performed iterative and mostly integrated within the process (Bissonette, 2016).

In the model of Hoseini, this aspect is tested based on the control measures that are applied within the risk management process, the secondary risks, and the extent to what the control measures are calculated and transit in project schedules and costs.

6. Monitor & Review

According the model of Hoseini, this aspect is related to making the process up-to-date. In which the risks, control measures, cost/schedule and probability and consequence should be up-to-date. In addition, the lessons learned should be recorded. Not only Hoseini state this importance within his model, also Jugdev and Müller (2004) mentioned that project success is also owing to diving into other projects, looking to best practices and communicating with other projects (Jugdev & Müller, 2005). In addition, Schuyler (2001) mentions the essence of post-project reviews for project members' learning and capturing knowledge (Schuyler, 2001). Monitoring and controlling the project is fundamental within project risk management (Bissonette, 2016).

4. Part A: Creating an Evaluation Framework

In this chapter, an Evaluation Framework is created that is essential for further research in Phase III. This Evaluation Framework is based on thirteen risk management standards. The structure of this chapter is based on the following main question and sub-questions:

1. ***What are the important steps in a risk management process?***
   a. What are the general differences between the risk management standards?
   b. What are the common steps of risk management standards?

4.1. Extensive research to risk management standards

Due to extensive literature research in the past by several researchers, a lot of risk management standards have been created. By defining which elements are necessary for an Evaluation Framework, extensive research techniques of Raz and Hillson (2005) and Hoseini (2017) are used. This extensive research consists of numerical scores on precise, pre-coded, variables (Swanborn, 2010). In this thesis, pre-coded are the elaborations on the criteria. The combination of these two kinds of research results in thirteen risk management standards. Some of these standards are bundled together due to similarities. Not all standards are applicable to use in the creating of the Evaluation Framework. Therefore, first, a research is done to define which risk management standards are applicable and necessary for further examination. This selection is based on the criteria: organization or project, definition, uniqueness, emphasis, sector, advantage, and disadvantage. The general background information of the standards will not be included, only the information of a standard that is necessary for further research. An extended version of the standard analysis is provided in Appendix E, F, G and H. A small glimpse on these risk management standards is given in this chapter. Further, the thirteen risk management standards are shortly explained.

AS/NZS 4360:2004

This standard provides a reference for directors, elected officials, chief executive officers, senior executives, line managers and staff when developing processes, systems, and techniques for managing risks that are appropriate to the context of their organization or their roles. The objective is to provide guidance to enable public, private or community enterprises, groups, and individuals to achieve the goals. This standard is not only defined as an organization but also as an individual (Zealand, 2005).

ATOM

The ATOM is not a real standard, according to Hillson and Simon (2005), it is a practical method that describes how to do risk management for a real project, rather than a theoretical framework or set of principles. They mention that one of the main CSF for effective risk management is a simple, scalable process (Hillson & Simon, 2007). ATOM offers such a process.

BS 6079-3:2000

This standard is mainly based on projects within the business. The maintenance of the database, communication, and explanation of risks, monitor effectiveness of the process, review objectives, decisions

and assumptions and update plan is an iterative process (BSI, 2000). These elements are considered in every step of the standard. Reporting is not mentioned in this standard.

CAN/CSA-Q850-97

This standard provides a comprehensive risk management process that will aid decision-makers in identifying, analyzing, evaluating, and controlling all types of risks. This process provides the information necessary to develop priorities. CSA Guideline CAN/CSA-Q850 (Standards, 1997) is intended to assist decision-makers in effectively managing all types of risk issues, including injury or damage to health, property the environment or something else of value. This guideline describes a process for acquiring, analyzing evaluating and communicating information that is necessary for decision-making. It should be noted that the process is iterative, and one can return to previous steps at any time throughout the process.

COSO

The COSO risk management guideline, which looks like a cube, consists of (COSO, 2004):

- Four objectives categories across the top of the model with vertical columns represent strategic, operations, reporting, and compliance objectives. The organization's operations and activities can fit into one, multiple or all categories.
- Eight components on the front face of the cube illustrating the Enterprise Risk management interrelated components. (Internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and communication, and monitoring)
- Multiple levels of the organization, from a headquarters entity level to individual subsidiaries.

The COSO explains that the eight components of risk management do not need to be implemented identically in every organization. While the application in a small and mid-size organization may be less formal and less structured, still, small entities can have effective Enterprise Risk management, if each of the components is implemented accurately.

FERMA and IRM

Both FERMA and IRM are mostly similar, IRM is a risk management standard created by three organizations called: The Institute of risk management, the Association of Insurance, and risk managers (AIRMIC) and the National Forum for risk management in the Public Sector (ALARM) (FERMA, 2002; IRM, 2002). Those two standards only differ in the order of the chapters and are combined. A lot of what is described in this standard is not in line with the scope of the thesis. Since there are good elements, it is used for further research. For example, the appropriate education and the vision of the standard on the implementation of the organization and their operations.

IEC 62198:2013

BS-IEC 62198 is an exact reproduction of CEI/IEC 62198:2001 by the British Standard Institute (BSI). The standard clarifies that risk management process should be integrated with both the project management processes and the product-related processes (Commission, 2013). BS-IEC 62198:2013 is based on the ISO 31000 but with a more project-related focus. Therefore, this standard is used instead of the ISO 31000. In 2013, IEC 62198:2001 has been revised. At present, the IEC 62198:2013 is the newest version of this standard. The elements that are changed are: (1) major restructure and rewrite of the first version and (2) it is now aligned with ISO 31000, Risk management - Principles and guidelines.

Where ISO 31000 focuses on the designing, implementing, monitoring, reviewing and continually improving risk management throughout an organization, IEC 62198:2013 does it for managing uncertainty in projects. It describes a systematic approach to managing risk in projects based on ISO 31000.

PRAM

It works well as a framework for discussion. Most specific risk management processes are described in terms of phases which are decomposed in a variety of ways, some related to tasks, some related to deliverables (Chapman, 1997).

PMBOK

The relation of project communication management with other inputs reveals that the PMBOK has considered an indirect relation between 'project risk management' and 'project communications management'. This suggests that the PMBOK project risk management should be considered with other knowledge areas. And it mentions that project risk is more than the sum of the individual risks within a project (Project Management Institute, 2013).

ISO 31000:2009

As already mentioned, the ISO 31000:2009 standard is similar to the ISO 62198:2013 standard. However, this standard is focused on the organization level and the ISO 62198:2013 is focused on the project level. Risk management is more than reducing or avoiding risks (ISO, 2015a). It is the development of a clear understanding of the risks that are important to the enterprise. These risks must be managed as the organization evolves and the operating environment changes through time.

IEEE Standard 1540-2001

The IEEE Standard is a critical tool for (1) continuously determining the feasibility of project plans, (2) for improving the search for and identification of potential problems that can affect software life cycle activities, (3) the quality and performance of software products, and (4) for improving the active management of software projects. However, the standard is affecting software life cycle activities and not construction life cycle activities. It is mainly based on the quality of products, and for improving the active management of software projects. Nothing is mentioned about time and costs. The focus elements in this standard are good but not applicable in this thesis (The Institute of Electrical and Electronics Engineers, 2001).

RISMAN

RISMAN is a standard that is highly based on the iterative control measure process. It is divided into two parts: the risk assessment and the risk control. This risk control part is an iterative process. However, a lack in the risk assessment part is recognized as no risk criteria are mentioned on which the risk identification is performed (Well-Stam et al., 2003).

PRINCE2

PRINCE2 has been derived from professional project managers' experiences and refined over years of use in a wide variety of context. PRINCE2's approach to the management of risk is based on OGC's publication management of Risk: Guidance for Practitioners (Cooke, 2016).

Based on the before-mentioned criteria, project or organizational based, definition and uniqueness, sector and emphasize, a selection for further research is made. The following risk management standards are analyzed by their process steps included in their standards since they seem to be applicable for further research: PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA and IRM, IEC 62198:2013, PRAM, BS6079-3:2000 and ATOM.

Every standard has a specific element that could be of additional value in the final Evaluation Framework. The emphasis of this thesis is project based since Heijmans already uses RISMAN within the organization. The way in which risk management is carried out at present is not how it ideally should go referring to cost

overruns, time delays, communication problems etc. This could rely on the Heijmans guideline or on the completion of the guideline. To find out if this relies on the standard, further research of the standards is necessary to eventually find out if the process of Heijmans is as complete as the standards are.

4.2. Intensive research to risk management standards

In this section, the selection of risk management standards is examined more in-depth. The selected standards are: PMBOK, CAN/CSA-Q850-97, RISMAN, FERMA and IRM, IEC 62198:2013, PRAM, BS6079-3:2000 and ATOM. Raz and Hillson (2005) stated that the process steps described by the selected standards contain the following main steps: planning, identification, analysis, treatment, and control (Raz & Hillson, 2005). Terminology differs between the standards, though, the structure of the process in each case is similar.

Appendix E contains an overview of the process steps as mentioned in the risk management standards in relation to the five elements that are mentioned by Raz and Hillson (2005) as the general elements in risk management standards (planning, identify, analyze, treatment and control). These elements are used as categories and form a basis of the tables in Appendix E, F, G, and H in which an extended version of the analyses are presented. Further analyses in this paragraph will elaborate on the correctness of the terminology of these elements. This chapter shows the results of the analysis.

Level of detail

The first difference that needs attention is the level of detail on the one hand and the level of vagueness on the other hand.

The Project Management Body of Knowledge (PMBOK) has only five steps mentioned, nothing clearly stated about the planning and control of risks. What is stated in the standard contains no level of detail that results in no additional value. The standard mentions 'risk management plan, identification, analysis, and response'. Of which only the qualitative and quantitative analysis is the level of detail that is mentioned.

In contrast to PMBOK, RISMAN mentions nine steps and highlights all the categories except the treatment of risks. RISMAN is divided into two main phases: risk analysis and risk monitoring. In both phases, respectively four and five elements are mentioned. Risk analysis is comparable to the 'planning and identifies' terms and risk monitoring are compared to the 'analysis, treatment, and control'. In this standard, it is hard to clearly divide the process steps into the categories as described by Raz and Hillson (2005).

IEC 62198:2001 seems to have a complete overview at first side. The standard mentions all the categories and has a lot of similarities with other standards.

CAN/CSA-Q850-97 seems to be inaccurate. Two of the five categories are not elaborated explicitly. The standard seems subjective and not unique. Nevertheless, the decision diamonds within the steps are unique. These diamonds cause an iterative process and trigger the project team to think constantly in a critical way.

Also, the FERMA and IRM standard cannot be divided into the categories in a proper way. Since the identification of the risks is part of the risk assessment: risk analysis contains the risk identification, description, and estimation. This standard seems to be more completely compared to the IEC 62198 standard. After the assessment of risks, the FERMA contains five steps and the IEC contains one step. The FERMA is more focused on reporting, decisions, and monitoring. However, IEC monitors and communicates

during the whole process and the decision is already made in the risk assessment part. From the tables in the Appendix E it seems that the FERMA is more accurate than the IRM.

Also, ATOM includes the risk identification in the risk assessment. ATOM mentions nine steps which seems complete but it is not unique. The ATOM model is comparable with the RISMAN model, in which first the risk analysis is carried out, in ATOM called: the initiation and risk assessment. Besides, it ends with an iterative process in which the risks are monitored. The difference is in the terminology.

BS 6079-3:2000 is similar as IEC 62198:2013: context, identify, analyze, evaluate, and treat. This all in parallel with communication, consultation, maintain, monitor, review, and update plans. The difference is in the description and the words they use. The planning phase is called in IEC 62198:2013 Organizational issues and in BS 6079-3:2000 Managing the process.

Terminology

There are several misunderstandings about the term risk assessment. ATOM includes identification, assessment, analysis, and response planning within the assessment. In contrast, IEC62198 includes analysis, evaluate and response within risk assessment and FERMA and IRM only include 'analysis and evaluation', others 'identification, analysis, and evaluation'. There should be a clear understanding of the meaning of the term and how it should be used to prevent confusion.

All in all, the standards are mostly similar, however, the difference is in the way of writing and in the iterative process. The most important thing is that the standards include the main elements, the way it should be carried out is mainly based on experiences (BSI, 2000, p.3) and make it a natural process of which the standard is used as a guideline. Table E.1, seeks for further research as it all seems to be similar.

The term 'reporting' mentioned in FERMA and IRM can contain another strategy as 'reporting' mentioned in ATOM. The standards are divided into the different categories. In Table F.1, the planning steps are explained. In Table G.1 the assessment strategies are explained and Table H.1 explains the control elements. This will give a more accurate conclusion in the end, in which the main intention of the standard will become clear.

Planning category

In the category 'planning', it is important to gain a lot of knowledge and insight information of the project. Planning is the input of the risk management plan if you do not have any knowledge of the project it might be the case that a lot of relevant information will lose. From Table E.1 it is seen that most of the standards contain similar, they should think about a lot of elements related to risks. Often the term context is used as an umbrella term for the risk management policy, the role of the board, the role of business units, the role of RM function, the role of internal audit, resources and implementation, etc. Therefore, the content of the planning category as mentioned in Raz and Hillson (2005) should be context. To define it more detailed, the context contains Strategic context, organization context, risk management context, stakeholder analysis and environmental context.

Elements of the identification, analysis, and treatment steps

Identification

Every standard has mentioned risk identification (Appendix E). Therefore, this category is essential to include in the Evaluation Framework.

Analysis

Some of them notice risk assessment, however, some standards (for example IEC 62198:2013) mentioned first identification and afterward assessment. FERMA and IRM and ISO31000 have risk identification included in the risk assessment. For the scope of the thesis, it is not necessary to define whether the identification should be implemented in the risk assessment or not. But it should be within the standard that is used to conduct risk management. Nicholas and Steyn (2012) state that the assessment of risks contains the likelihood, impact, consequences, and priorities (Nicholas & Steyn, 2012). They mention that managing risks in projects contains risk standards, risk identification, risk assessment, risk response planning and risk tracking and response. It is necessary that the assessment is carried out in a proper way within the analysis.

When evaluating these standards and creating the Evaluation Framework. The identification of risks and the analysis of risks is separated. The analysis of risks includes the risk assessment in which the likelihood, impact, consequences, and priorities of risks are determined. The risks can be documented in a risk dossier. A risk dossier is a document that contains a clear overview of the risk, cause, event, consequences, impact, risk owner and response on this risk. These risks must be evaluated, evaluations make the analysis an iterative process.

Treatment

Since the treatment is part of the control and the control is part of the treatment, it is hard to separate and define it in a proper way. Raz and Hillson (2005) separated these terms which leads to overlap. For control, there are two different controls, namely control of risk treatment actions and control of risk management process. The main elements of the risk treatment are risk control, response plan, and risk treatment.

Risk control

Control is part of the treatment of the risks. Control is necessary to review and monitor risks. According to PMI (2013), it is the process of implementing risk response plans, tracking identified risks, identify new risks and evaluating the risk process effectiveness throughout the whole project duration to continuously improve risk responses (Project Management Institute, 2013). Implementation of the risk response plan, execute responses and evaluate response are mentioned in the treatment of risks. It is of additional value to having a clear distinction between the terms treatment and risk control. As can be seen from Table H.1 the control is divided into control of risk treatment actions and control of risk management process.

4.3. Important steps within risk management: Evaluation Framework

This subsection is used as basis for the analysis in the further chapters. The aim of the Evaluation Framework is find differences between theory and practice to identify factors that could have an influence on the quality of risk management performance. An extensive study resulted in eight risk management standards that are in line with the scope of the thesis. These eight standards are studied intensively and essential elements are identified. According Raz and Hillson (2005) the essential elements are: planning, identify, analyze, treatment and control. By dividing the eight standards in these categories, it appeared that some elements repeated multiple times (for example risk identification), while others occur once (for example project sizing). The extended version of this analysis is shown in Appendix E, F, G and H.

According to Hoseini (2017), it is proposed that risk management processes should contain all following essential elements and must be an iterative and ongoing process (Hoseini, 2017b). First, risk management initiation. Concerned with fundamental issues required for performing an appropriate risk management such as top management commitment, availability of a sound risk management policy, resources, etc. Second, risk analysis. Concerned with identifying the risks, formulating them, and quantifying them. Third,

risk evaluation. Concerned with preparing a list of the most important risks which require action to avoid or reduce the consequences. Fourth, risk treatment. Concerned with selecting and implementing the best risk response strategy. Fifth, monitor and review. To check if the applied control measures are useful and checking the possibility of occurring new risk. Finally, post-project review. Concerned with capturing and recording the lessons learned for future projects. Besides the eight risk management standards, the essential steps of Hoseini (2017) are included since his research is leading in the case study.

In the previously examined standards the following elements are not (often) mentioned but make a process unique in a positive way related to their process: stakeholder, environment, risk within the whole culture, education, and post-project review. Of these elements, the stakeholder analysis, environmental context, organization context, and post-project review could have a positive influence on the risk management process. Therefore, these elements are considered while formulating the Evaluation Framework as well.

To answer the question of the paragraph based on the literature review, the Evaluation Framework should contain the following elements. The elements that resulted from the research as carried out in paragraph 4.1 and 4.2 are project context, risk identification, risk assessment, and risk response. These four elements should contain the following and must be performed as an iterative process, see Figure 4.1.
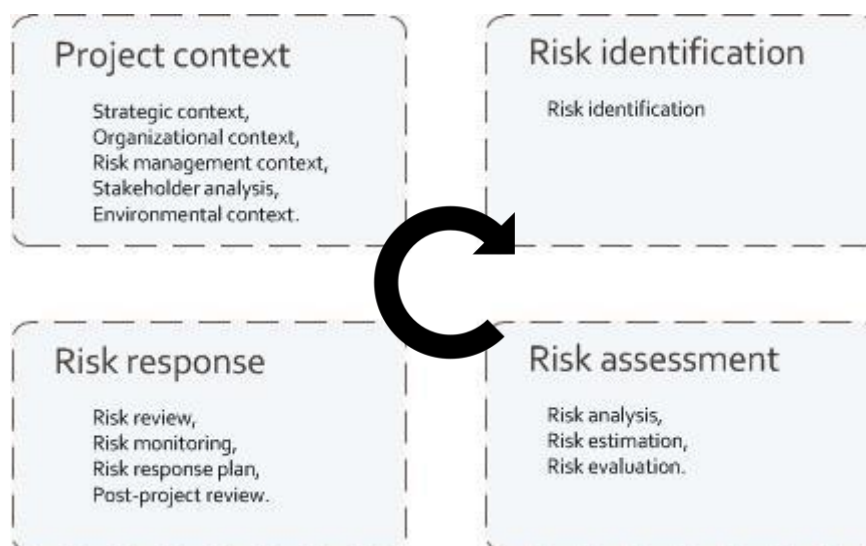
Figure 4.1. Evaluation Framework.

In the rest of the thesis the above elements of the framework will be referred to as the Evaluation Framework. First, these elements of the Evaluation Framework are considered while analyzing the elements in the guideline of Heijmans.
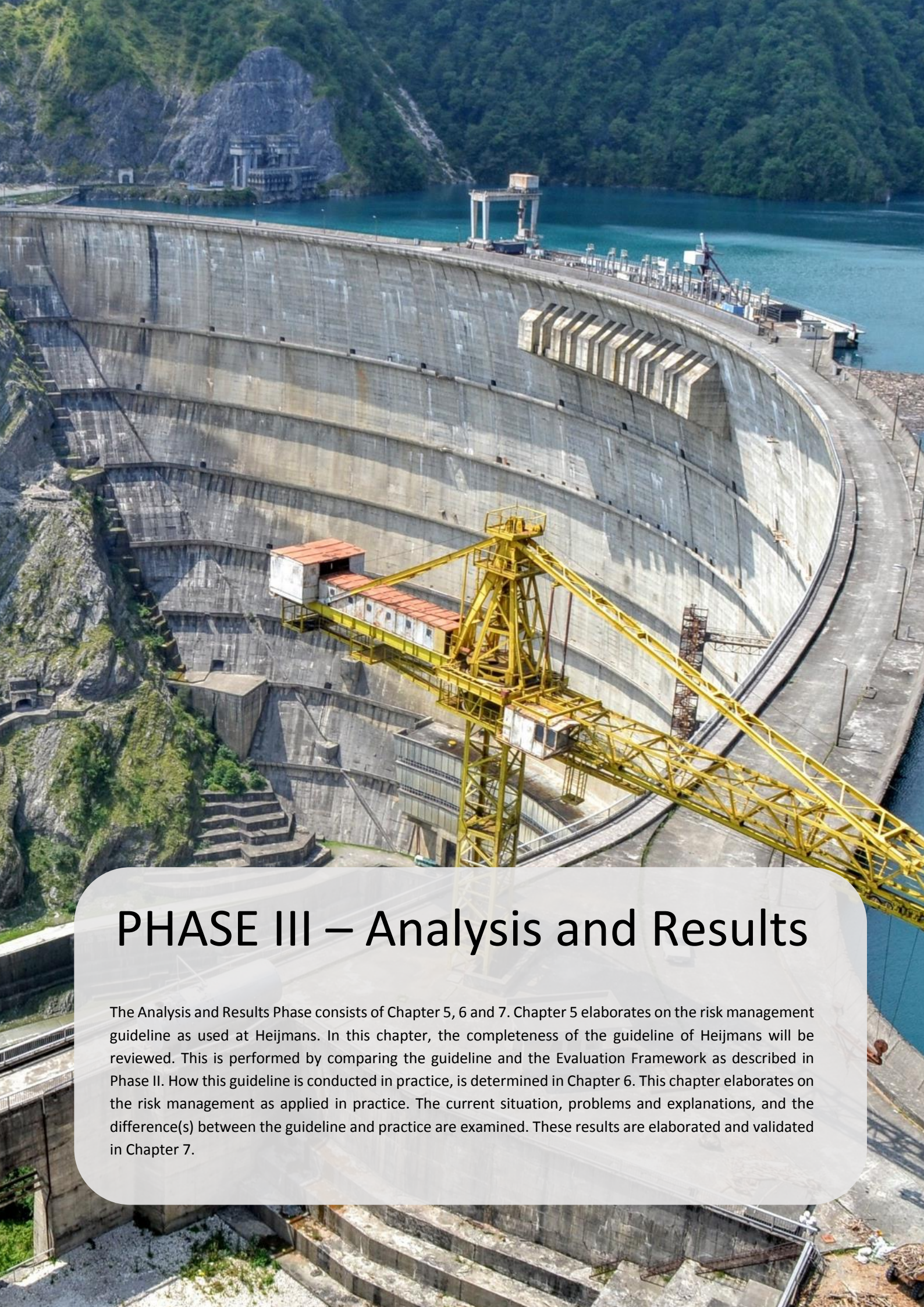
PHASE III – Analysis and Results

The Analysis and Results Phase consists of Chapter 5, 6 and 7. Chapter 5 elaborates on the risk management guideline as used at Heijmans. In this chapter, the completeness of the guideline of Heijmans will be reviewed. This is performed by comparing the guideline and the Evaluation Framework as described in Phase II. How this guideline is conducted in practice, is determined in Chapter 6. This chapter elaborates on the risk management as applied in practice. The current situation, problems and explanations, and the difference(s) between the guideline and practice are examined. These results are elaborated and validated in Chapter 7.

5. Part B: Guideline of Heijmans

At present, within Heijmans there is a large focus on risk management processes both in projects, as well in the organization. Processes within the organization and within the projects. In this chapter, the risk management guideline within Heijmans is discussed based on documents which are stored in the online database. As mentioned in Section 1.1., this risk management guideline is based on the RISMAN method, elaborated in Chapter 4. In general, RISMAN focusses on both risks and opportunities. Regarding the scope of the thesis, only the risks (with negative impacts) are being discussed. Chapter 5 dives deeper into the guideline as described at Heijmans (Section 5.1). This section includes an intensive research as it is based on field documents (Swanborn, 2010). This is relevant to compare with Part A and examine what the differences are. In this chapter, the link between Part A and Part B is analyzed (Section 5.2). This follows from the second sub question:

2. ***What are the differences between the Heijmans guideline and the Evaluation Framework?***

5.1. Risk management guideline of Heijmans

In March 2016, Heijmans published documents internally in which the risk management procedure is described (Ebskamp, Meer, & Viveen, 2016). This document is described as a format to use at the start of every project. Besides this document, a document for safety risks is created as result of the safety importance at Heijmans. In this phase, only the guideline about reducing risks that are project specific and their control measures will be analyzed. Those risks that are not part of the normal processes.

Risk management is a process that interface other project processes as described in PMI (2013). Heijmans uses the ISO 15288 as leading format to manage these processes. This format gives guidance for the implementation of the 26 System Life Cycle Processes of the ISO 15288 (ISO, 2015b). Of which the risk management process is one. To keep this whole risk and system engineering process up-to-date, Heijmans makes use of a platform called Relatics. This platform helps to control the projects and manage the project information (Relatics, 2017). Relatics shows all the elements that are related to the processes within a project and should make managing processes easier, see Figure 5.1.

Omschrijving	Actiehouder	Status	Datum gepland gereed	Aantal werkdagen tot datum gepland gereed	Kosten	Toelichting	Bewijsdocument	Afgeleide eis	Werkpakketactiviteit	Evaluatie: maatregel was...
Lean sessie houden en maatregelen doorvoeren.		Wordt doorgevoerd	2017-06-09	-71						
Afstemmingssessies (formeel en informeel) met WTB en civiel houden.		Wordt doorgevoerd	2017-08-25	-16						
Gebruik Go / No Go formulier voor optimalisaties.		Is doorgevoerd		-						
Stick to the plan, geen wijzigingen doorvoeren.		Wordt niet doorgevoerd	2016-12-01	-						
Volgen van 1 ontwikkelproces		Is doorgevoerd	2016-12-01	-						

Figure 5.1. Example overview Relatics.

At the right, the project structure at Heijmans is presented in a simplistic way. The highest position, blue dot, is the project director, followed by the management team (black dots). The management team members give direction to smaller project groups, shown in the light blue dots. What is not shown in this picture, but present in real projects, are the project members who work at the project side and execute the project.
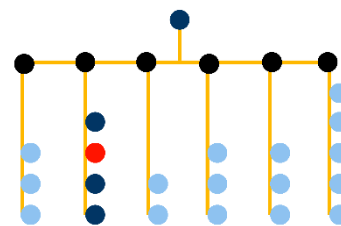
The risk management process is performed by mainly three roles: the risk manager, the risk owner, and the action holder. The risk manager (red dot) facilitates the process and keeps the system, Relatics, up-to-date. The risk owner must evaluate the control measures, is responsible for risks, and should communicate the state-of-the-art to the risk manager. Mostly, this is a member of the management team (black dots). The action holder must conduct control measures (light blue dots or even lower). Everyone in the project should identify risks and communicate it to the risk manager.

In general, at Heijmans, risk management is used to measure and mitigate the impact of uncertainties on the project goals (Ebskamp et al., 2016). The risk management procedure of Heijmans consists of seven main steps (See Figure 5.2) and is based on the RISMAN method. Mostly, step 1 is performed in the tender phase. Within this process, the last four steps must be an iterative process. Appendix I shows the extended risk management process in which the input and output of these steps are formulated. Figure 5.2 and Table 5.1. show the guideline of Heijmans. Figure 5.2 shows the main steps with the iterative process in the end, Table 5.1. includes the sub-steps within every main step.
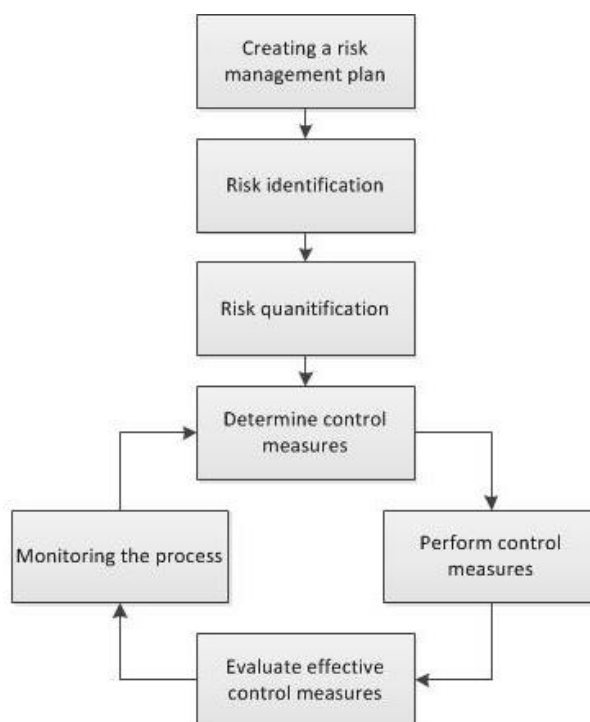
Figure 5.2. Risk management guideline of Heijmans

Main process	Subprocess
1. **Creating a Risk Management Plan**	Reading contract documents
	Set up project-specific Plan of Action for risk management by requirements of the client
	Adjust plan of actions with the core team
	Adjust plan of actions with client
	Instruct project team about risk management
	Design tooling with project specific formats
	Make decisions about how to deal with access to client
	Support in the use of tooling and designing
2. **Mapping of risks**	Distribute contract documents over the risk-owners for the first screening
	Read contract documents
	Organize and lead risk sessions
	Determine causes, consequences, risk-owner, and risk-taker per risk
3. **Quantify risks**	Quantify risks
	Determine most important risks (top X) through the criteria of the plan of actions
4. **Determine control measures**	Determine and choose preventive risk control measures
	Quantify rest risks
	Determine and choose corrective risk control measures
	Determine action holder per risk control measure
5. **Execute control measures**	Practice risk control measures
	Monitor risk control measures and adjust risk quantification
6. **Evaluate effective control measures**	Evaluate effectiveness of the risk control measures
	If necessary: determine new or additional risk control measures
7. **Monitoring of the process**	Set up documentations

Table 5.1. Overview of the guideline of Heijmans.

Step 1: Creating a Risk Management Plan.

This step has seven sub-processes that are mainly based on setting up the context of the project. The input of this step is based on the EMVI criteria and the contract. EMVI is the Economical Most Valuable Submission, in Dutch: Economisch Meest Voordelige Inschrijving. The output is a 'DeelManagementPlan' in which the scope of the project and the relation to other project processes is described. This 'DeelManagementPlan' is leading in this thesis for the performance of risk management. As mentioned, this step is normally performed in the tender phase. The management team of the project must agree upon the quantification table, acceptation levels of this table and project goals which are described in the 'DeelManagementPlan' document. First, the 'DeelManagementPlan' must be checked and agreed upon before the risk management plan can be approved. The project team will be instructed by a kick-off presentation of a project-specific explanation.

Step 2: Identify the risks

Identification of the risks is done with the input of the contract, the requirements of the client, risk sessions,

risk meetings and the proposal for change. For every risk above the 100.000 euros, the causes, consequences, the risk-owner, and the action holder are determined within this step. Identification of the risks is done as follows:

- In risks sessions, mostly divided into several sessions with a certain focus theme.
- During bilateral risk meetings with risk-owners.
- Face-to-face with the risk manager. Every member in a project can provide risks to a risk manager. The risk manager will add these risks to the risk dossier after discussing it with the future risk-owner of that certain risk.

This results in a risk dossier documented and managed in Relatics. This risk dossier forms the basis of the whole risk management process and all relevant risks are elaborated in this dossier.

Step 3: Quantify risks

Quantification of risks is done regarding a project-specific quantification table in which the structure is already defined for the whole organization, only the numbers must be made project specific. Risk quantification will be done by the risk-owner. In the end, the aim of the quantification is to give a rough estimation about the priority of risks, for example the top 3 risks. Based on the project criteria, the most important risks will be determined. This quantification table will only be used for category 2 and 3 projects. For category 1 projects, the quantification is determined in the risk dossier.

Step 4: Determine control measures

The risk-owner chooses the control measures for the risks that are above the acceptation boundary of that certain project, which results from the quantification table. There is a difference between preventive and corrective control measures. Heijmans prefers more preventive control measures instead of corrective control measures. Preventive control measures are the control measures to prevent the risk. Corrective control measures are those measures that reduce the impact after the risk exposure. In this step, the risk-owner appoints the action holder. The action holder is responsible for the execution of the control measures and determines which control measures are more efficient regarding the costs in relation to the returns.

Step 5: Execute control measures

The action holder executes all the risk measures that are linked to him/her in the risk dossier. If this measure is implemented, it should be discussed with the risk owner. If the control measures are implemented in a sufficient way, the status of the control measures will be changed in the risk dossier. For example, executed or in progress. The risk owner is (end) responsible for the progress and execution of the risk measures linked to him/her.

Step 6: Evaluate effective control measures

The risk will be evaluated by the risk owner based on the feedback of the action holder. The status of the risk is evaluated based on one of the following conditions:

- Effective measure; the actual risk will be mitigated and other control measures are still open
- Effective measure and risks are controlled; the last measure with an open status and the actual risk is mitigated to a rest-risk. The risk is controlled.
- Ineffective measure, additional measures should be taken; the actual risk is not mitigated.
- Ineffective measure, additional measures which are not cost efficient; the last measure is executed, but this one has not mitigated the risk sufficient enough. The secondary risk became larger.

Step 7: Monitoring of the process

To monitor a certain risk and make sure the process is structured, Heijmans uses five techniques. First, a consultation structure, in which meetings take place with (1) the management team, the risk owner and risk manager and (2) the client. Second, it makes use of reports and documentation. Three reports are made, (1) one progress meeting every month, (2) one quarterly report every quarter and (3) a KPI[2] report of the risk manager every month. Third, is the documentation which is done in Relatics. Fourth, are the (project specific) KPI's which are used to test the process internally. This is done by monitoring:

- Amount of risks per risk status per risk-owner
- Amount of control measures that have passed the date per risk-owner
- Amount of new risks
- Amount of control measures with the status 'will be implemented' without a date per risk-owner
- Amount of control measures with the status 'will be implemented' without risk-holder per risk-owner
- Amount of implemented risk management measures without evaluation per risk-owner

Fifth, the process evaluation that can be filled in by the project team themselves. If the evaluation is defined, it should be confirmed with the KAM-advisor[3] and improvement measures should be implemented in the improvement actions. In the end, if the risks are not controlled, it is important to start from the point where the iterative process starts. If the risks are measured, the risks can be treated by updating the risk dossier and the status of the measured risks will be changed.

5.2. Difference between Evaluation Framework and guideline of Heijmans

A comparison between the Heijmans guideline (Section 5.1) and the Evaluation Framework (Section 4.3) is made to determine the differences. The strategy used in this section is comparable to the intensive research strategy used in Section 4.2, based on Raz and Hillson (2005).

LEVEL OF DETAIL HEIJMANS GUIDELINE

The guideline of Heijmans, as shown in Appendix I, shows a clear overview of the risk management process. A clear in- and output is included which gives more hands on the process and what is expected. The level of detail of the Heijmans guideline at some points highly detailed and at some not. For example, the ways in which the risk control measures can be evaluated. For other sub steps, for example determine control measures, no elaboration is given on certain strategies or manners on how to perform this step. The steps 'identification of risks', 'evaluation of risks', and 'monitoring of the process' are described highly detailed. While other steps seem to give the project members more freedom in the manner of fulfillment.

TERMINOLOGY OF HEIJMANS GUIDELINE

Chapter 4 presented the different terminology used in standards. Nonetheless, the meaning is often similar. By comparing the Evaluation Framework and the Heijmans guideline, the difference in terminology is noticeable. The terms 'instruct project team' and 'quantify risks' are not mentioned before. The quantification of risks is comparable to the risk estimation. Risk estimation is seen as estimating frequency, consequences, methods, and techniques (Nicholas & Steyn, 2012). The terms 'identification of risks' and 'monitor' are similar in terminology within both the Framework and guideline. These steps are elaborated in more detailed in the following paragraphs.

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[2] KPI: Key Performance Indicator
[3] The KAM-advisor is a quality, working conditions and environment advisor. In Dutch: Kwaliteit, Arbeidsomstandigheden en Milieu.

PLANNING CATEGORY HEIJMANS GUIDELINE

The planning phase is an important part of the whole project process. A good start is beneficial for the rest of the project. However, the planning category is mainly part of the tender phase. The risk management approach as described in Ebskamp et al. (2016) is a process that is part of the whole project from tender to the end of the project. Therefore, the risk management plan should be created at the start of the project, the tender phase. However, while comparing the guideline and the Framework, this part is considered as well.

The Evaluation Framework mentions the additional value of clearly formulating the strategic context, organizational context, environmental context, and risk management context and the performance of a stakeholder analysis. From the guideline, it seems not be included while setting up the risk management plan. Table 5.2 presents the terminology in the Evaluation Framework, terminology in the guideline of Heijmans and the difference or if there is no difference (-).

Evaluation framework	Guideline of Heijmans	Difference
Strategic context	Reading contract documents	Not explicit described but the strategic context as mentioned in the Evaluation Framework can result from reading contract documents
Organizational context	Instruct project team about risk management Support in the use of tooling and designing	The guideline does not pay attention to the organizational context. This is probably determined before the risk manager is appointed and the process starts
Risk management context	Set up a project specific risk management approach	-
Stakeholder analysis		Only focused on the client
Environmental context		Environment manager is part of the project team and communicates the risks

Table 5.2. Differences between Part A and Part B in the planning phase.

From conversations, it seems that some differences are included in practice or in the risk dossier. For example, an environment manager is part of the management team. This environment manager must include their identified risks in the risk dossier. Obviously, the environment manager first set up the environment context, so indirectly it is considered, however, the risk manager did not conduct it as part of his/her role. It should be asked if it is necessary to make it part of the risk management process or adjustments would be enough. Adjustments can be related to as setting up the risk management plan with all members of the management team. At this moment, the risk manager already sits together with the risk-owners and elaborates the most important risks. But this is mainly performed in the design phase instead of the planning phase.

ELEMENTS OF IDENTIFICATION, ANALYSIS, AND TREATMENT STEPS HEIJMANS GUIDELINE

Both Evaluation Framework and Heijmans guideline focus on the identification of risks. In the 'risk identification' of Heijmans the determination of the cause, consequence, risk-owner, and action holder is mentioned. Within the Evaluation Framework, a clear division is noticeable 'risk analysis', 'risk estimation' and 'risk evaluation' (See Table 5.3). The terminology in the guideline 'quantification of risks' is rare in the risk management process but can be compared to risk estimation. The differences appear in 'risk analysis' and 'risk evaluation'. These steps seem to lack in the guideline, as the guideline goes immediately from risk identification, to risk quantification to determination of control measures. In which the steps risk analysis

and risk evaluation are not performed. However, these steps are performed mainly related to the control measures. These will be elaborated in the risk control phase.

Evaluation framework	Guideline Heijmans	Difference
Risk identification	Risk identification	-
Risk analysis		Terminology
Risk estimation	Quantification of risks	Included in the quantification
Risk evaluation		Not included

Table 5.3. Differences between Part A and Part B in the identification, analysis, and treatment phase.

RISK CONTROL

This part is about controlling risks and seems to overlap with the risk treatment of the previous subsection. The iterative process presented in Figure 5.2 is based on control measures and part of the risk control category. To control a risk, control measures are determined, performed and evaluated.

The 'risk control' and 'risk response' are mentioned several times in previous mentioned standards. However, based on the Evaluation Framework, 'the post-project review' is lacking.

Evaluation framework	Guideline Heijmans	Difference
Risk review	Evaluate control measures	-
Risk monitoring	Monitor the process	-
Risk response plan	Determine control measures, execute control measures	-
Post-project review		Post project-review is lacking

Table 5.4. Differences between Part A and Part B in the risk control phase.

Moreover, the Evaluation Framework does not explicitly mention monitoring of the process. Several standards presented documentation as an ongoing process during the whole time span of the risk management process. As the documentation reports are performed monthly and quarterly, it seems to be an ongoing process too. However, in the Evaluation Framework, documentation/monitoring is not explicitly mentioned. Only the post-project review is mentioned.

In general, consistency of the guideline and description of the steps is important. While project members will identify their search in a glimpse instead of diving into documents which is time consuming. Some sub steps that are described in Table 5.1 are not described in the elaboration per step and important tasks which are described in the description of the step are not mentioned in the table.

5.3. Conclusion differences Evaluation Framework and Heijmans guideline

The guideline as described at Heijmans is mostly complete compared to the Evaluation Framework. Heijmans described their guideline in a detailed way, for example, mentioning 'instruct project team', 'read contract documents' and 'support in the use of tooling and designing'. The Evaluation Framework is created on an abstract level, which makes it hard to compare with the detailed steps described in the Heijmans guideline. This level of detail is beneficial while working on the risk management process. It gives more guidance in what is intended within a certain step. However, the details are mostly related to the input and output of the step. The way of performing the step is often not explicitly mentioned. This freedom can a disadvantage for project members which are not familiar with the process. Therefore, it is important for Heijmans to determine for who and which audience the guideline is intended

The Heijmans guideline is based on the RISMAN process, which results in a well-designed and well-described guideline. In comparison with the Evaluation Framework, more attention is paid to the control measures, three out of four steps include control measures. Control measures are important factors in a risk management process to reduce risks. Therefore, focusing on control measures is beneficial.

The scope of the thesis is the improvement of the risk management process in large infrastructure projects. Which means that the improvement areas should be identified. Therefore, the three differences resulted from the comparison between the Heijmans guideline and the Evaluation Framework which will be considered for further research are:

One of the shortcoming elements in the guideline is the lack of considering 'risk evaluation'. Risk evaluation is necessary to perform as further steps in the process are considered. It is likely that the steps of risk evaluation will be followed. However, it is not mentioned specifically. Within the risk assessment part, mainly risk quantification is mentioned and not risk analysis and evaluation.

Shortcoming in the context of the guideline of Heijmans. The context is considered in the risk management plan. However, only limited to the contract documents and the client. Most often the risk management plan is a tool to confirm the risk management actions. In contrast, some of these steps are already conducted in the tender phase. However, it is important to conduct, for example, the stakeholder analyses during the whole project span due to the dynamic environment in which stakeholders can change.

Shortcoming in post-project review in the guideline of Heijmans. The post-project review is neither mentioned. The post-project review is about capturing and recording the lessons learned to apply them in future projects.

6. Part C: Risk management in practice

Chapter 5 formulated five differences between the Evaluation Framework and guideline of Heijmans of which three differences are considered for further research. These elements are: shortcoming in the context, missing post-project review and the risk evaluation. Nonetheless, the guideline of Heijmans is concluded as complete, besides those shortcomings. To determine the differences between the guideline of Heijmans and risk management in practice, risk management in practice at Heijmans is examined based on an intensive case study (see Section 6.1). Additionally, the difference(s) between the guideline (B) and practice (C) is/are identified, see Section 6.2. In which the following sub questions will be answered.

3. *To what extent is the risk management carried out in practice?*
   a. What is the current risk maturity situation at Heijmans?
   b. What are the difference between the Heijmans guideline and the risk management in practice?

6.1. Problem analysis

The motivation for the approach of using the GRMM to determine the current risk maturity situation at Heijmans is based on the necessity of having a clear overview of the current risk maturity to define goals, processes and manage progress in raising risk management capabilities (Zou et al., 2010). To determine the current risk maturity situation, quantitative and qualitative data is gathered. This is based on an intensive study as interview transcripts are the initial data sources for the qualitative data (Swanborn, 2010). The 9 respondents, that form the basis of the gained data in part C, are part of the projects X, Y and Z and non-'één ontwikkelproces' projects. An explanation of these respondents is given in Section 2.3.1.

Data gathering

The data gathered from the GRMM is based on several levels (See Figure 6.1). As shown in Figure 2.4 and elaborated in Section 3.3., there are six aspects that contain in total 51 statements. These statements are ranked by the respondents and results in a certain risk maturity level per aspect. Every subsection of Section 6.1 starts with the results of this risk maturity level per aspect: the gained quantitative data. Moreover, the quantitative data (mainly the low ranked statements as improvement areas must be identified) is used as input for the questions to gain the qualitative data. The qualitative data is derived from explanations of the respondents related to the statements. In this way, it provides insight in the motivation behind the scores. The focus in the qualitative study is on the lower ranked scores to formulate improvement areas. These statements and explanations are presented after the risk maturity level per aspect in every subsection. In the end, chapter 7, the results of these in twofold gained data is presented.
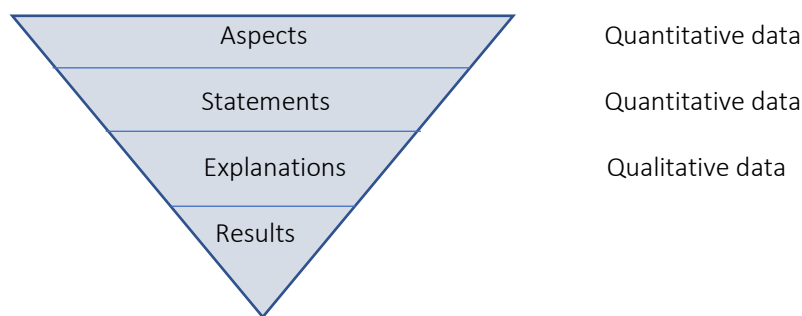
Figure 6.1. Converging level of detail based on the several layers of gained data.

6.1.1. Project X

This project contains a rebuilding of a sewage farm in the Netherlands. Additional information of Project X is formulated in Appendix B. Within this project a consortium was created of three companies. First, this section shows the current level of maturity based on aspect level. Second, the level of maturity and ambition level on statement level are considered. In the end, the explanations are considered to define the cause of differences between the managers and/or causes for the level of implementation. The scope of this thesis is to identify the improvement areas, therefore, mainly the statements and explanations of the low scores are appointed and the statements and explanations of the high differences between the level of implementation and ambition level. With improvement areas, it is not per definition a failure within the project. Improvement area are those elements that should be raised to achieve a more successful project.

Aspects

Figure 6.2 gives an overview of the current situation in Project X. The numbers (range from 0 – 10) present the level of risk maturity per aspect. By analyzing these numbers, it can be stated that Project X is risk mature. As most of the numbers are above 5 and stated as mature. The lowest average per aspect is 4.9, ranked by the risk manager for 'Risk Treatment'. The risk manager ranked four of the six aspects with an average between 4.9 - 5.7. The lowest average per aspect according the design manager is 6.9. From these results and Figure 6.2, the design manager is more positive than the risk manager. The reason for this could be the knowledge about the implemented risk management factors. Since the risk manager designed and facilitated the risk management method and, therefore, knows exactly what is (not) performed. For the design manager, a lack can occur and ranks the scores feeling-based. Another reason could be the work environment, for example, the design manager could work in a risk-driven team and/or is highly risk aware.

The aspects 'Risk Assessment' and 'Policy & Strategy' are most risk mature with, respectively, an average of 8.2 and 7.9. Both aspects are related to pre-defined systems and processes. The smallest level of maturity is in the aspects 'Monitor & Review' and 'Culture & Personnel knowledge'. The lowest differences appear in the aspects 'Risk Assessment' and 'Monitor & Review'. Low deltas present a more reliable result since more respondents agree on this level of maturity. The largest differences between both managers occur in the aspects 'Risk Treatment' (Δ = 3.6) and 'Top management commitment' (Δ = 3.0). The aspects with the large differences are less reliable as their level of implementation strongly disagree. Therefore, the results of 'Risk Assessment' and 'Monitor & Review' are most reliable and respectively the most mature and less mature aspect.
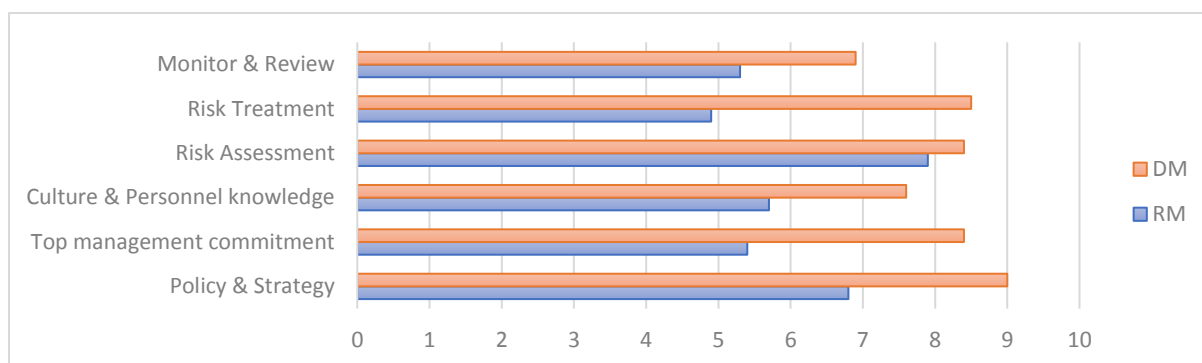
Figure 6.2. Risk maturity score of the design manager and risk manager per aspect of Project X.

Statements

In this section the statements with a (1) low score of implementation and a (2) high difference in level of implementation and ambition are considered. Section 2.4 and 2.5 elaborate on the calculation of these statements. Of both kinds, the three statements that have the most negative influence on the performance of risk management are considered. The in total 6 statements are presented in Figure 6.3, in which these statements are divided into six aspects and the communication component (elaborated in Section 3.3). This figure presents the high amount of 'Monitor & Review' statements that are prior to improve. Second, the 'Communication' and 'Culture & Personnel knowledge' are improvement areas. The statements that are the input of this figure are shown in Table 6.2. The statements considered in this figure are linked to qualitative data to gain insights in the motivation, see Table 6.2.
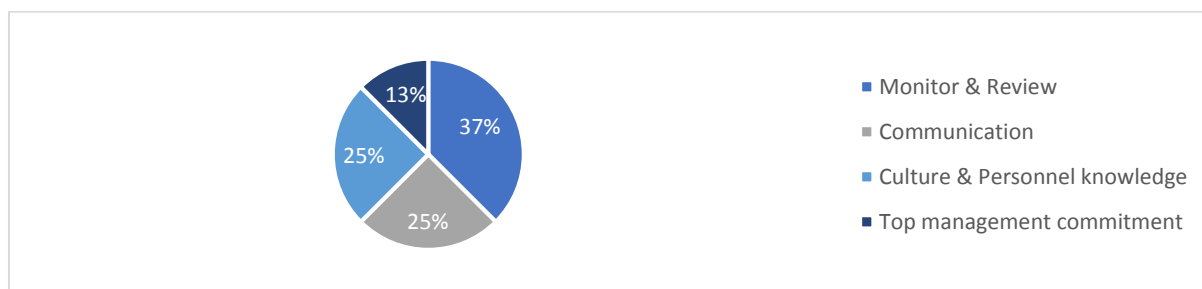
Figure 6.3. Percentage statements per aspect of Project X.

In total, there are twelve statements ranked with the combination 3-7 by both respondents. Which means that those respondents have a slight difference in ranking the statements. The cause could be a difference in interpretation.

Three statements are ranked with a large difference between the respondents: 0-10, 0-7 or 3-10 (or vice versa). This difference is large, which means that the cause is probably not a different interpretation. The cause for this can be a lack of knowledge as it is a highly detailed element of the risk management process. Or it is a statement about the management team, in which project members hesitate on ranking it negative while the other does not hesitate.

Only three statements are ranked as insufficient (score of 0 or 3) by both managers. Two of these statements are related to the 'Monitor & Review' aspect and one is related to the 'Culture & Personnel knowledge' aspect. The first four rows in the first column of Table 6.2 show these statements, aspects and the explanation related to the statements.

The statements with the highest difference between the level of implementation and ambition score are presented in the lower three rows. The difference with the previous mentioned statements is that not all

respondents ranked these statements with a 0 and/or 3. This can result in a lack of explanation by the interviewees since only the negative ranked statements were an input for further questions during the interview. These three statements are all related to other aspects, namely: 'Monitor & Review', 'Culture & Personnel knowledge' and 'Top management commitment'. The reason for this could be the level of ambition per persons. If one statement is not implemented in the risk management process and it has no priority for the respondent, the ambition level will be more comparable with the level of implementation than when the respondent thinks the statement is important to implement and ranks it with a large ambition level. A limitation what was recognized during the interviews where the way of ranking the ambition level of statements. Some respondents filled in the ambition level as 'it can always be better'. See the first column, lowest three rows in Table 6.1.

Explanations
Based on the explanations presented in the Table 6.1, the following quotes are relevant for further research:

"*Less focus on risk management*"
This is confirmed by the risk manager as he mentioned that the System Engineer role receives more attention than the Risk Manager role. In which he mentioned the relation with time pressure, especially at the beginning of the project the focus was more on SE according the risk manager. This seems to be realistic as there are several processes involved in this project regarding the ISO 15288 standard. As a System Engineer, these processes have to be set up at the beginning of the project. Risk management is one of the processes of ISO 15288 and receives more attention due to the importance.

"*Risk management is not performed explicitly, but implicit*"
This explanation is linked to the statement about the risk awareness of the project team. This explanation is not confirmed or validated by the project team, therefore, it cannot be assumed as a fact. However, when the level of risk maturity is considered, the highest level of maturity is based on 'Risk Assessment' and 'Policy & Strategy'. Both aspects are related to the system behind risk management. Which seems to validate the level of maturity of the systems. The aspects 'Monitor & Review' and 'Culture & Personnel knowledge' are the lowest in risk maturity and are based on social aspects and the level of performance. The statement is mentioned by the risk manager as a difference in properly performance, this seems more liable than completely not performed explicit. Especially, since the risk manager appoints the difference per team regarding the level of mentioning risks.

"*It is on own initiative to dive into projects*" and "*Due to time pressure*"
People should take own responsibility to record the lessons learned. According the design manager, it is due to time pressure. However, it can also relate to responsibility or ownership, for example, if it not the tunnel you have to design, people will not feel the responsibility to record these lessons learned. Or lack of documentation, for example, if no one ever documented the lessons learned, why would someone start documenting? Or, it can be related to the organizational culture, people may be less risk-driven or are experience-driven. All these examples could cause the low level of recording lessons learned and therefore have to be considered in this thesis, till it is validated.

"*The risk manager should have a proactive attitude*"
The design manager mentioned this about the risk manager. This reactive attitude is not validated by the risk manager. However, he mentions by himself that "there is a lack of focus on risk management", system engineering receives more attention than risk management, especially at the beginning of a project, see column 3 in Table 6.1. This does not validate the reactive attitude of the risk manager but it highlights the lower given attention to risk management and way of performing risk management in this project. The lack of proactive attitude can be related to the lack of necessity to implement certain statements. This was

Aspect	Statement	Explanation
Monitor & Review	Lessons learned (occurred risks, performing risk management, etc.) are recorded	"It is on own initiative to dive into projects. We don't do it as a design team, due to time pressure." and ".. documentation of elements that we could not have foreseen is not performed."
Monitor & Review and Communication	The outcome of monitor and review process is documented and communicated to internal and (if needed) external stakeholders	"Mostly to external stakeholders." and "It is performed. However, it is not part of the risk management process."
Culture & Personnel knowledge	The personnel receive training (if needed) to improve risk management skills	"The risk manager elaborates why that number is used for a certain element." and "There is a lack of focus on risk management. For me, the focus is more on System Engineering. Especially, at the start of the project. After a couple of weeks, the focus became more on the risk management processes."
Monitor & Review	Lessons learned (occurred risks, performing risk management, etc.) are recorded	
Culture & Personnel knowledge	The project team is aware of his risk attitude	"It is not performed explicitly but implicit. I am wondering if the project team is aware of their risk attitude. The risk manager should have a proactive attitude and ask for risks by project members. The reactive attitude must be changed into a proactive attitude." And "The risk attitude differs a lot per team. Some team members visit me and want to discuss how to manage the risks. But there is a clear difference per team. For the design team, it is not done properly and often performed later. For the construction team, it is better performed. Often, I am amazed about the late stage in which risks are mentioned."
Top management commitment and Communication	Management communicates goals and strategies of risk management within the project.	"Maybe, the strategy is communicated at the start of the project but I have not recognized it."

Table 6.1. Overview of aspects, statements and explanations of Project X.

mainly in combination with the low level of importance. The risk manager mentions "In general, if people think about risks and what they can do with it, it is sufficient enough. Moreover, I do not see the additional value of explicit mentioning when someone already thinks about it."

"*The risk attitude differs a lot per team*"
It is not validated that the risk attitude differs per team. However, the risk manager noticed a slight

difference between the design team and the construct team. Why this slight difference occurs is according the risk manager based on the affinity with risks. This is not validated, this difference can also occur based on team spirit, a more risk aware manager. Or the difference on mentioning causes to people below the hierarchical level instead of above.

The design managers stated that the consortium firm had a positive effect on the project team. "the consortium firm is strong in certain elements in which they can strengthen the team and vice versa. Heijmans stays at the surface, while the consortium firm reacts more direct". In addition, he mentions the well-organized 'Policy & Strategy' aspect, which he substantiates with: "describing is one, but performance is two". A lot of statements were substantiated with "it could be performed a bit better". Which can be related to the sufficient level of maturity but there are always improvement points. The risk manager states that the risk management is well performed, but is never appointed in such detail. Which makes it hard to rank the level of implementation. A lot is performed implicitly. Therefore, he mentions that risk management can be improved by improving the whole risk management experience in which the following explanations are stated: (1) "Awareness within the project team", (2) "How everyone is involved in risk management", (3) "How the tool can be made more alive" and (4) "Everyone must be active with it".

These explanations are mentioned as a bottleneck by the risk manager. Most of these statements are related to someone else. It is hard to validate that the awareness in the team is not enough due to the two respondents within this project. Nevertheless, from the ambition level it resulted that the project awareness can be highly improved. And not mentioned as insufficient by both managers.

The design manager mentions that "someone has to be proactive in making the tools better. According to the design manager, the tool is an additional tool besides their main task. So, someone should spend time on making risk management better. That could be better in the future. However, it is twofold. On the one hand, making it more manageable to control the risks and on the other hand, one person who is proactive and making sure everyone is more risk aware. The risk manager has two functions that makes this hard." So, both managers explain that the double role of risk manager and system engineer influences the risk management performance within the team. But is this measurable?

In addition, several explanations can be linked to the 'Monitor & Review'. As the risk manager mentioned "the administrative burden is a bottleneck" and "you must perform it, therefore, it is often performed later". The design managers agree on this and mentions "using the tool is a threshold" and substantiates it with "it is additional work" and "the tools are not created well enough". In addition, the role of risk manager is combined with the role of System Engineer. Both roles include a lot of documentation and managing the processes. This results from the explanation "I have never performed risk management from the start of the project. An improvement would be enlarging the capacity for risks". The design manager confirms this "What can be seen from practice, is the amount of attention the role as System Engineer claims. Therefore, risk management is something that comes later". Other causes that are mentioned in the explanations are time pressure and the design team not being physically attached to risks.

While conducting the interviews, the question arose what are the bottlenecks in this project regarding risk management? These explanations elaborate on the bottlenecks within project risk management. These explanations are important to include to ensure all problems in practice are included in this study. From these explanations became clear that the risk attitude is mostly there, however, the quality of the risk management process disappears as it is performed not completely. The following quote of the design manager confirms this 'The most important step is taking preventive control measures. Most of the time, this is enough but we do not accelarate. We do not pay any attention to the rest-risks. We have implemented control measures to mitigate the level of impact'.

6.1.2. Project Y

Additional information of Project Y is presented in Appendix B. This project is the first pilot project regarding the 'één ontwikkelproces' method. It contains a road infrastructure project near Amsterdam. The project team of this project consists of four companies that worked in a consortium. This project is the first pilot project regarding the 'één ontwikkelproces' method. This section formulates the current level of maturity based on aspect level. Second, current level of maturity and ambition level on statements level. In the end, the explanations are considered to define the cause(s) for the difference(s) of the level of implementation regarding both managers. Also in this section, only the less mature statements and their explanation for the cause will be considered since improvement areas must be analyzed. Which can also be mature statements that can or should be improved.

Aspects

Figure 6.4. presents the current level of maturity outcome of the quantitative data. According to the risk manager, all elements of Project Y are risk mature. Unfortunately, it is hard to compare these results with the results of the design manager since 8 statements are filled in with a question mark. These statements are recognized as 0 by the GRMM and were mainly part of the 'Monitor & Review' and 'Risk Treatment' aspects (See Figure 6.4). The statements that are ranked with a score were mainly very positive, except the 'Culture & Personnel knowledge' (See Figure 6.4). Which leads to an unrealistic, crooked result in the diagrams and risk maturity average. Therefore, the data is not representative to compare based on the information of this figure. The elements that will be considered, based on this figure, for the quantitative analysis are 'Risk Assessment', 'Culture & Personnel knowledge', 'Top management commitment', and 'Policy & Strategy'. While considering those four aspects, it can be stated that aspects 'Risk Assessment' and 'Policy & Strategy' are most mature. The delta of these aspects is smallest and therefore these results are most reliable since they both agreed upon this high level of maturity. Since only four aspects are considered, the less mature aspect is 'Culture & Personnel knowledge'. The variation between both scores is 1.5, which can also be concluded as reliable since the deltas of other aspects and other projects are mostly higher. Besides, the variation between two scores in the model is already 3, and therefore, the variations smaller than 3 are acceptable.

The risk manager has an average score of 7.8 and the design manager of 7.2. Even with the question marks, the design manager has a high average. The reason for this could be his background and comparison reference of other (maybe worse managed) projects or the successfully, as he mentioned, first use of the 'één ontwikkelproces' method. Considering the reliability of the used model, this project is stated as risk mature since the numbers in Figure 6.4 show a high-risk maturity.
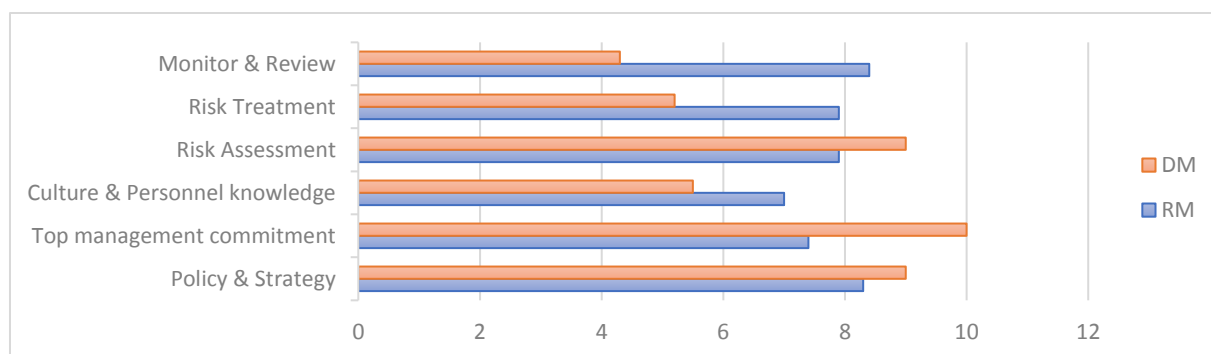

Figure 6.4. Risk maturity score of the design manager and risk manager per aspect of Project Y.

Statements

The current situation on statement level is shown in Figure 6.5. These results give a clear overview of the distribution within this project. Most statements (both low maturity as high ambition level) are divided equally among the aspects. However, what is recognized is the high percentage of the communication component. However, what also can be stated from this figure is the high mature aspect 'Policy & Strategy' since this aspect includes none of these statements.

At a statement level, three statements are ranked with a 0 and/or 3. All three statements are related to other aspects: 'Culture & Personnel knowledge', 'Risk Treatment' and 'Monitor & Review'. Of which, two are related to 'Communication'. The reason for the of lack in communication can be find in the qualitative data, presented in the next paragraph.

The ambition level statements also present three statements that are all related to another aspect: 'Risk Assessment', 'Risk Treatment' and 'Top management commitment'. This is clearly shown in Figure 6.5. Nonetheless, two of the three statements are part of the 'Communication' component. To calculate the ambition level, only the data of the risk management of Project Y is considered due to the large amount of unfilled statements by the design manager. Due to the question marks entered by the design manager, less explanations were mentioned.
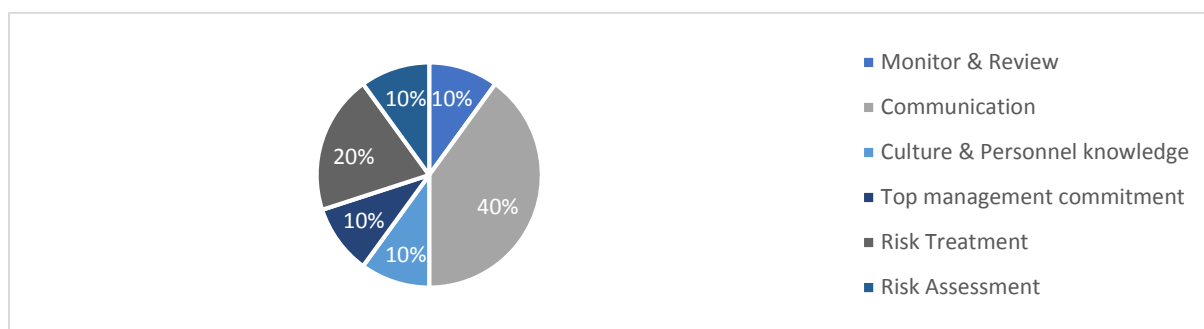
Figure 6.5. Percentage statements per aspect of Project Y.

Explanations

Of the six mentioned statements, four are part of 'Communication' component. Within these statements, documentation is mentioned as well. Regarding the quantitative data, a lack is recognized in the documentation and communication elements. In the explanations of the risk manager, it is a result of the complexity and lack of integral work by project members. However, it could also be related to changes within the organization, hesitate to mention risks that have a small chance of occurrence or lack of being open and transparent. The causes mentioned by the managers are highlighted in the next paragraph.

"Integrality is difficult for a lot people since people are raised monodisciplinary. It is already hard to secure your own complex work, ideally, you also want to see what influence your work has on others". The risk manager explained: "It requires a lot of communication, it is not that we cannot arrange it. This kind of work requires a lot of burden for your own work. Of which the DBFM-contract is a cause." If this DBFM contract is the cause, should be examined. DBFM is a new contract form in which design, built, finance and maintain are the contractor's responsibility. For most of the project members this form is new. For this reason, it can be reliable but it is not validated. In relation to this complex work: "it takes a lot of time before people understand that small actions can have a high impact on the project. Project members do not understand the context, they are too focused on their own tasks which can be dangerous". While project members are instructed at the beginning of the project, as described in the guideline, the context should be clear. Besides,

this context is mentioned within the Evaluation Framework as essential element in the process. It should be of additional value if the cause of this lack of context is examined.

The risk manager elaborated "Within the project there are communication facilitators" as an action to stimulate communication. However, those facilitators do not completely stimulate this communication. In addition, "If the boss state that A must be performed, A will be performed by the project members. They immediately follow the boss. In complex projects, a lot of interaction between people is present. The management team should be aware of this interaction. However, being aware of all these interactions is hard". From these explanations, it seems that communication within risk management is an out of control position. Actions are already taken by the project organization. It is possible that those actions are not effective due to the out of control position, or other actions should be taken to stimulate communication and documentation. The design manager elaborates that communicating SMART is necessary within this complex project, however, "it is hard to define risks and choices SMART due to the complexity of projects".

In addition, the risk manager prefers a better communication about the process elements. "Some people are wary to be complete. The risk manager should have a proactive attitude at these moments since there are people that prefer to not discuss risks. Their active risk attitude can be improvement." This is said about the risk manager and other project members, and therefore it cannot be assumed as a fact. The reactive attitude of the risk manager is not validated. However, the risk manager elaborates that the proactivity in risk management is a bottleneck. This is elaborated by the fact that a risk manager is necessary in the project. If everyone is risk aware and risk driven, a risk manager should not be necessary. The risk manager states "ideally, every professional must identify the risks in this project. He must react on these risks in an active way. At present, a risk manager is needed to encourage this, that is fine for the time being."

After analyzing these discussions, the cause for a lack of communication is, regarding the risk manager, the large amount of complexity in this project and therefore, the integrality. This project is complex due to the DBFM contract. Integrality is hard since people are raised monodisciplinary. It is hard for people to understand the context as they are too focused on their own task. This complexity and integrality requires communications. But is this true? The ways on how to manage complexity is already mentioned by Hertogh and Westerveld (2010) and elaborated in section 3.1. In their research, the main finding was that managing complexity is mostly outside the control of a project manager. Project Y was the first combination of the consortium, this could also be the cause for the lack of communication as everyone is used to another manner of communication. However, following the boss if he states A can be related to the mentality of people in the project or hierarchy and has nothing to do with complexity. For example, if a teacher tells a student to change a certain sentence, he will change it since receiving a lower score could be the consequence.

However, this is mainly based on communication. As documentation is also mentioned in these statements, the cause should be formulated. The risk manager mentions in the explanation on the previous page that he motives people to document by sitting together and tell them how to document and perform this together. In this way, people will learn how to document and receive a small training by the risk manager. But if this is the cause of lack of documentation should be examined. "The management team must be integrated in the project, in this way they will hear more about risks". "The management team is risk aware, nonetheless, the levels beneath them are less risk aware." In addition, "The people need to go through a process. The risk manager should explain them what the additional value is and show them what is mentioned in management team sessions. His issue should become a shared issue. Than it is necessary to write it in a document". Most of the statements are in the implementation as he mentioned. "The challenge

is in the implementation. That is the point when the risk manager is not needed anymore. The group involved has to do it."

In addition, the respondents mentioned the implicit way of performing the mentioned statements. Implicit risk management seems to be a cause for the low level of statement implementation within this project. Once, it is stated due to lack of time. The personnel do not receive training due to time. No time is considered for these training and therefore it is performed during the project span.

In this project, the risk management plan is written to fulfill the contract requirements, too much freedom is left since it only fulfills the requirements. This freedom makes risk management hard to conduct since no uniform approach is considered in projects. "At Heijmans, we are not uniform in the approach and vision of risk management". "More clarification about the abstract level and identification of risks. For a project member, it was not nice to spent so much time on risks and all the requirements and characteristics. A lot of elements had to be filled in and I prefer the risk manager to do that for me. It is helpful to talk with everyone about what is expected from every project member regarding risk management at the beginning."

What worked well in this project regarding both managers was the "naming and shaming" in which project members were linked to a certain object, for example a tunnel, and were responsible for all the risks related to this object. In this way, responsibility and ownership was clearly available. The risk mind-set was mostly present in the project, the project members understood the necessity of risk management. In addition, asking project members if they have made plans to control a risk works often. They will start thinking about how to manage the risks and therefore a preventive control measure is performed. Regarding the risk manager, it is necessary to involve people in the process. Mentioning what they must do is not effective.

Aspects	Statements	Explanations
Culture & Personnel knowledge	The personnel receive training (if needed) to improve risk management skills	"There is no training to improve risk management skills." And "We do not train the people explicitly. Off course we are busy with all the project members. But we do not walk through the whole process. This is also time dependent. No time it considered to educate the project members on how to manage the risks. During the whole project, we try to educate them."
Risk Treatment and Communication	The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders	"We perform risk management mainly implicit and not explicitly." Besides he tries to motivate people to document by "Going to the project teams, sitting together and tell them how documentation must be performed. They are not immediately proactive but they have the first contact with it. Together, documentation in Relatics is done."
Monitor & Review and Communication	The outcome of monitor and review process is documented and communicated to internal and (if needed) external stakeholders	"There is improvement in sharing risks with stakeholders but now, too little risk sessions are organized with the client. We have organized several sessions with the client and contractor. But that is not enough."
Risk Assessment and Communication	The risk assessment outcome is documented and communicated to internal and (if needed) external stakeholders	Both interviewees did not elaborate on this.
Risk Treatment and Communication	The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders	This statement is already elaborated in this previous table.
Top management commitment	Management uses risk management reports to make decisions	"This is done implicit, reports are not considered for every decision"

Table 6.2. Overview of aspects, statements and explanations of Project Y.

6.1.3. Project Z

Additional information of Project Z is presented in Appendix B. This project contains a road infrastructure project near Utrecht. And started latest of all three projects with implementing the 'één ontwikkelproces' method. This section elaborates, first, on the current level of maturity based on aspect level. Second, on statement level including the low ranked statements and highest ambition level. In the end, the explanations are combined to define the cause(s) for the difference(s) between the managers in the statements and explanations.

Aspects

In Project Z, the risk maturity numbers show significant difference between both interviewees (See Figure 6.6). Specifically, the aspects 'Monitor & Review' and 'Policy & Strategy'. This difference is confirmed by the diverged average score of the risk manager of 8.4 and the design manager 6.4. The design manager scores low on the aspects 'Monitor & Review', 'Culture & Personnel knowledge' and 'Top management commitment'. While the risk manager only 'Top management commitment' confirms with a low maturity level, nonetheless, it still has a ranking of 7 out of 10 (See Figure 6.6). Which means that these aspects are high on maturity – confirmed by the averages of both respondents – but still large differences between both respondents occur. The elements that can be improved will be highlighted in this section.

The largest differences between both respondents occur in the aspects 'Monitor & Review' ($\Delta = 4.3$), 'Culture & Personnel knowledge' ($\Delta = 2.5$) and 'Policy & Strategy' ($\Delta = 2.5$). These high differences result from the elaboration of the risk manager as he elaborated: "These scores are filled in with the point of view: I mention that I score sufficient at Project Z regarding my 'own' process. This is logical and would not be good if it was not. My process is based on the project ambitions (and contract) and the available tools." This is also the reason why no statements are ranked with a 0 and/or 3 by both respondents. Therefore, only the ambition level is considered at a statement level. Which results in a limitation of lack of information, due to the available ambition level statements and no current situation statements. The ambition level statements are not always statements with a low ranking, and therefore, not explained.

This project shows high deltas, which means that it is hard to define what is positive in this project and what is less well-performed. Due to the quantitative data it can be stated that Project Z scores high in the risk maturity level in the current situation. From this figure, it can be stated that 'Policy & Strategy', 'Risk Treatment' and 'Risk Assessment' are most mature in this project. The most immature aspects are 'Culture & Personnel knowledge' and 'Top management commitment'. The high level of maturity in this project is reliable due to the lack of similar low stated statements.
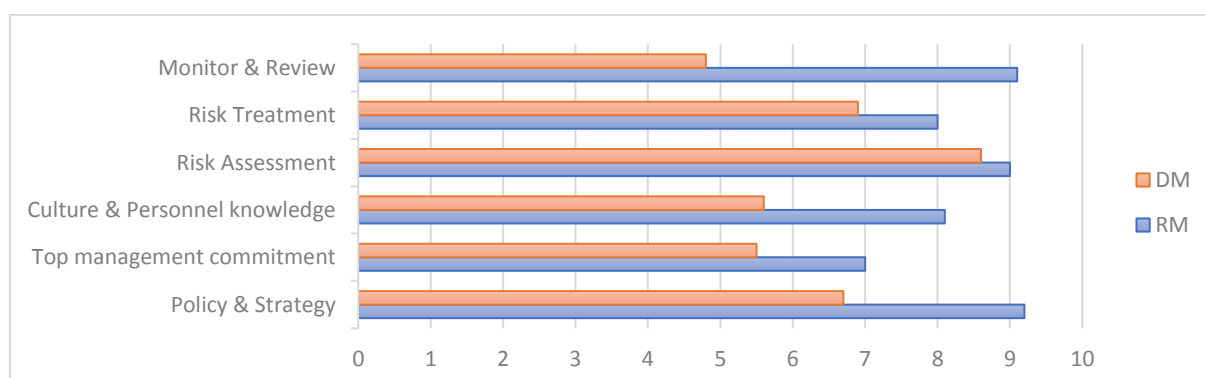

Figure 6.6. Risk maturity score of the design manager and risk manager per aspect of Project Z.

Statements

Nine statements have a high difference in ambition level. The high difference of ambition level is based on an outcome of 70 regarding the formula mentioned in Section 2.5. Three statements are part of 'Risk Treatment'. For each aspect of 'Policy & Strategy', 'Monitor & Review', and the component 'Communication' two statements are mentioned. These numbers are presented in Figure 6.7.

What is noticeable, is the not alignment of the low maturity aspects of the current situation and the high ambition level statements. Those two less mature aspects score even lowest regarding the amount of ambition level statements per aspects (see Figure 6.7). This is notable and will be analyzed by considering the explanations. The aspects, statements and their explanations are shown in Table 6.6.
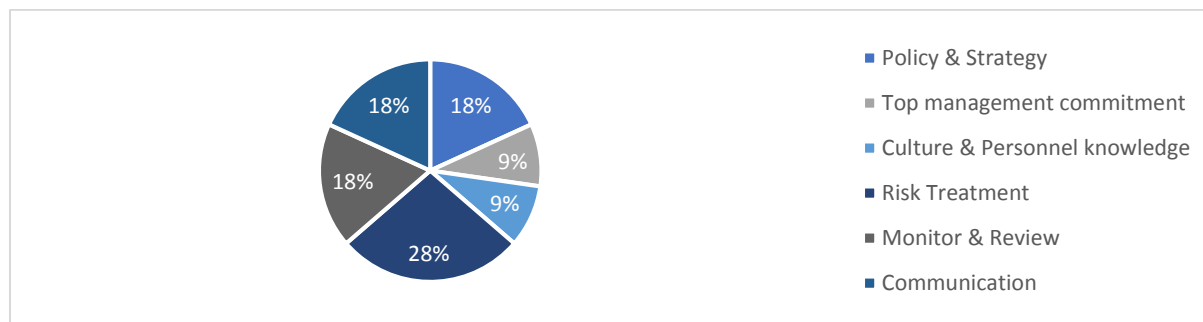
Figure 6.7. Percentage statements per aspects Project Z.

Explanations

'Risk Treatment' is mentioned most often as improvement aspect. The explanations related to the statements within these aspects are (see Table 6.3): "in practice it is not done", "nothing is mentioned about the implementation", "Preferably we communicate the process, but than it is still not implemented". "It is not well communicated to the external stakeholders", however, in contrast, the design manager substantiates it is performed conform the contract and agreements between the mother companies. As mentioned in the interview with the risk manager of Project X, if the client requires level 3 on maturity, why would you go for level 4? It seems that in most projects no more actions than required in the contract are conducted. Agreed upon by the design manager that the risk management plan is constructed based on the contract requirements and leaves too much freedom for the implementation strategy. It seems that there is a lack of performance in risk management due to only considering the contract requirements instead of clearly mentioning the performance of the risk management process for the project members in practice.

What is noticeable, is the contrast between the quantitative and qualitative data based on statement 'the contractor risks, identified by the client, are communicated to the relevant contractors'. This statement is one of the nine statements out of 51 in total that are high to improve. But is elaborated by the risk manager as: "it is limited of importance" and substantiates it with "the client has limited influence". Diving deeper into the scores, the risk manager ranked all three columns with a 7. The design manager ranked the level of implementation with a score of 0 and the level of importance and ambition with a 10. Which means that the total amount of ambition level is 100 (the maximum), minus the ambition level of the risk manager (0) gives a high total ambition level of 100. The cause for this could be a wrong interpretation of the statement, lack of communication within the project process or, for example, the satisfaction of the risk manager with his own designed strategy. This should be examined. Although, this statement is a detailed step within risk management, it is likely that these small steps are taken without communicating to the rest of the project team. This can also be the reason for the well-performed risk management process regarding the risk manager and the slightly less performed risk management process regarding the design manager. The

design manager of Project Y confirms this by "I do not see everything, as I have a limited view on the detailed risk management process".

The risk manager mentions the risk management processes and the tools several times. The risk dossier is used as main tool and used in a procedural manner of taking care of risks. "On projects, I am not busy with specific technical or execution risks. On other projects, it could be designed in another way. Within the 'één ontwikkelproces' projects, there are risks that relate to design/construction/asset and there are theme's that are included in the general risk dossier (dependent on size and level of integration)." All in all, he thinks it is well implemented as he is the risk manager and arranges his own process.

The statements that are important regarding the risk manager are 'There is no blame culture and the project organization accepts that people make mistakes', 'The project team has trust and openness in reporting risks', and 'The project team is aware of his risk attitude'. Which seem to be related to the 'Culture & Personnel knowledge' aspect.

The statements that are of less importance for the risk manager seem to be related to decision-making, based on documents and/or strategies. Confirmed by his opinion of the larges bottleneck in this project and related to the following statements. 'The entire risk assessment process is performed based on the project risk management process' and 'Management defines roles (with authority and accountability) to perform risk management process within the project'. This is in line with making decisions based on feeling, experience and emotions of the day as mentioned by the design manager. "For these things, we do not inform RISMAN. It is more a feeling, experience and emotion of the day. I cannot remember a moment that we informed the dossier for making a decision. Only the advantages and disadvantages are mentioned."

In contrast to the immature level for 'Culture & Personnel knowledge' the risk manager mentioned: "all in all, the culture and personnel knowledge is positive at Heijmans. The mind-set boundary is at the drawing. Also in drawings there is a difference between a real designer who is less risk aware compared to the execution/construction organization. They think more about the safety of their employee." But this is never validated. It is easily said about the drawing teams, but it is possible that those levels of the project team are more risk aware but at a detailed level and not at a process level.

The design manager mentions that the goals are well documented, although, project members have to search for the feasible documents. Due to changes in the project team, information get lost. The lack of 'Communication' can be related to "The former integral design manager has established this, so knowledge gets lost on several fronts." The changes within the organizational structure can cause nescience of who is responsible and important risk information might get lost. However, documentation should limit the lost information. Therefore, other causes can be related to communication as for example no uniform approach of documentation or monitoring the process. In addition, risk management is one of the 26 processes of the ISO 15228, this means that all of the processes have to be at the same level. Risk management is possibly not perfectly implemented, but it is hard to implement all these 26 processes perfectly. Those processes have to be at the same level.

The design manager explains the reactive attitude of the risk manager. According the design manager, the risk manager mainly focusses on the risk management system. The rest of the team must add and/or implement these risk in the dossier, this results in a not uniform risk dossier. "it is preferable if someone makes this system continuously uniform". However, hundreds of risks are documented in this dossier, which can also cause a priority for the risk manager to only update the top X risks and make these uniform.

Aspect	Statement	Explanation
Policy & Strategy and Communication	The risk appetite document of the project is internally communicated and available	"There is no specific risk appetite document. In the tender phase, a strategy is determined in which chances and risks are set against each other. This is documented and reviewed in several rounds with the management team and/or the board."
Top management commitment	Management defines roles (with authority and accountability) to perform risk management process within the project	"Everyone can add risks in the systems and link risk owners to it, but this is not good. This leads to nescience of risk ownership of elements. The management only decides the role of risk owner when there is a disagreement. First, it is solved internally. However, it leads to irritations when I get a risk and know it from the system."
Culture & Personnel knowledge	There is an experienced person responsible for risk management	Both have not say anything about this statement.
Risk treatment	The whole risk treatment and mitigation process is based on the project risk management process	"In practice, this is not done. 'The risk register is of everyone and for everyone' is documented in the guideline. However, nothing is mentioned about implementation. Preferably, we communicate the process with everyone, but than it is still not implemented. We should ask the persons, walk to them, and see how it is going."
Risk treatment and Communication	The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders	"Internal yes, external no. The client is external. The risk dossier is visible for everyone. It is visible in such a way that you must be cautious about what the client can see. In the future, we want to plan a session with the client." "and "Conform the contract and agreements between the mother companies."
Monitor & Review	Status of the control measures are updated and Status of risks are updated in the risk register (active, managed, occurred)	"There is no deadline to keep it up-to-date. It can be done better and pay more attention to it." and "There is always a delay in updating the risk dossier. The focus is on the bigger themes."
Risk Treatment	The contractor risks, identified by the client, are communicated to the relevant contractors	"It is limited of importance. The client has an amount of process risks in their dossier that are not in the contractor's dossier. The contractor controls this, the client has limited influence."
Policy & Strategy	The procedure for deciding risk reservation is based on the defined risk appetite of the project	"Before submission of a tender, a first identification is done. It is more on organization level and less on project level. During the project, there are GO and NO-GO moments, mostly these requirements are based on the contract. If the project started, we cannot quit anymore. Risk appetite is not completely integrated in the projects. We have a goal that we want to achieve with the whole team." And "In theory, it is. In practice, some other factors have an influence: commerce, timing, financial model, expectation management"

Table 6.3. Overview of aspects, statements, and explanations of Project Z.

6.1.4. Cross case analyses

The interrelations are separated into the (1) cross case analysis in the projects, (2) cross case analysis all interviewees and (3) the roles.

Cross case analysis in the projects

From the quantitative data at aspect level, it can be stated that all three projects are well-performed regarding risk management (See Table 6.4). This table shows the mean, standard deviation, and sample variation of all respondents of the projects X, Y and Z. This table excludes the design manager of Project Y due to the amount of questions marks that are recognized as 0 by the GRMM. This table shows the high averages of the aspects. Figure 6.8 shows the averages of both respondents per project. Also in this figure, the design manager of Project Y is excluded. From this figure is noticeable that none of these projects score below a 6 out of 10.

In general, all three projects show a positive result for the aspects 'Policy and Strategy' and 'Risk Assessment'. The systems are well designed. The mean is respectively 7.08 and 8. The standard deviation is respectively 1.6 and 1.02. Which results that the 'Risk Assessment' is more mature and stable aspect within the projects.

	Policy & Strategy	Top Management commitment	Culture & Personnel knowledge	Risk Assessment	Risk Treatment	Monitor & Review
Mean	7.08	6.84	6.50	8.00	6.44	6.20
Standard deviation	1.58	1.37	0.83	1.01	2.09	2.11
Sample variation	2.49	1.87	0.69	1.03	4.39	4.46

Table 6.4. Mean, SD and Sample variation per aspect for all projects

Within all projects it could be stated that ´Culture & Personnel knowledge' is an overall less mature aspect. Regarding the averages, it seems that there is a contrast. The average of this aspect is 6.5. While the average of aspect 'Monitor & Review' is 6.2 and 'Risk Treatment' is 6.44. However, the standard deviation of the 'Culture & Personnel knowledge' is 0.83 and the standard deviation for 'Monitor & Review' and 'Risk Treatment' is respectively 2.11 and 2.09. The difference in standard deviation can also be formulated from Figure 6.8. This means that the 'Culture & Personnel knowledge' is a more stable low aspect by all interviewees than 'Monitor & Review', which fluctuates a lot.

The largest sample variations occur in the 'Monitor & Review' and 'Risk Treatment' with respectively 4.46 and 4.39. However, the averages are closer to each other. This means that the respondents within projects ranked the statements with large differences. In section 6.1.1, 6.1.2. and 6.1.3. the deltas between the managers are mentioned. However, these sample variations confirm these enormous high deltas'. The high differences could be related to the point of view of the managers. All respondents have different backgrounds and different reference points regarding project teams and risk management approach. Besides, consortia are a common project management approach. Within these projects, several consortia worked together, which could influence the results. In addition, of every project, only two interviewees are considered. Therefore, the results shown in this section assume that both respondents show a representable view on the risk management in practice.

The smallest differences occur in the aspects 'Risk Assessment' and 'Culture & Personnel knowledge'. With a sample variation of respectively 0.69 and 1.03 and a standard deviation of 0.83 and 1.01. In general, the

averages per project are close to each other. Respondent in Project Y is generally more positive than in Project X and Project Z. However, the limitation in this case, is that the scores depend on a single respondent.

Figure 6.8. Interrelations between project X, Y and Z.

Within the projects, only in Project X and Project Y both managers ranked similar statements as insufficient. 2 out of the 51 statements are recognized as insufficient by all of them. Therefore, it can be stated that most statements are well implemented in the projects. These statements are: 'The outcome of monitor and review process is documented and communicated to internal and (if needed) external stakeholders' and 'The personnel receive training (if needed) to improve risk management skills'. The statements that are mentioned by two of the managers as insufficient are: 'Lessons learned (occurred risks, performing risk management, etc.) are recorded' and 'The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders'.

The statements that have a high difference in the level of implementation and their ambition score, are project specific. Only one statement is mentioned by two projects as high priority to improve: 'The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders'. What is noticeable, is the amount of statements related to documentation and communication. These statements are, together with the previous statement: 'The risk assessment outcome is documented and communicated to internal and (if needed) external stakeholders', 'The risk treatment outcome is documented and communicated to internal and (if needed) external stakeholders', 'The risk appetite document of the project is internally communicated and available'. Within the whole project, there are 5 statements related to communication and 4 out of 5 are mentioned as improvement. The statement 'Management communicates goals and strategies of risk management within the project' is not recognized as a communication statements in the model. Although, it relates to communication. In addition, the following statements were mentioned.

'Culture & Personnel knowledge':
- 'The project team is aware of his risk attitude',
- 'There is an experienced team/person responsible for risk management'.

'Monitor & Review':
- 'Lessons learned (occurred risks, performing risk management, etc.) are recorded',
- 'Status of the control measures are updated (in progress, applied, not applied yet)',
- 'Status of risks are updated in the risk register (active, managed, occurred)'.

'Top management commitment':
- 'Management uses risk management reports to make decisions',
- 'Management defines roles (with authority and accountability) to perform risk management process within the project'.

'Risk Treatment':
- 'The whole Risk Treatment and mitigation process is based on the project risk management process'.

'Policy & Strategy':
- 'The procedure for deciding risk reservation is based on the defined risk appetite of the project',
- 'The contractor risks, identified by the client, are communicated to the relevant contractors'.

The quote that concludes how risk management in seen in practice is: "*For me, the RISMAN standard is a standard in which a ranking from 1-5 is done based on 4 or 5 aspects. The rest risks that appear should be quantified and a control measure must be determined. This process is conducted, and the format in Relatics is based on this process. I would not even know how it can be performed in a better way*" - DM of Project Z

Cross case analysis of all interviewees

In the figures below, interviewee 4 – the design manager of Project Y – is excluded as these aspects are not all filled in correctly. Figures 6.9. and 6.10 show the high differences in scores between all interviewees. These figures mainly show a large difference between 'één ontwikkelproces' projects and non-'één ontwikkelproces' projects. The averages per aspect shown in Table 6.5, slightly differ from the results shown in Table 6.4. The largest differences between Tables 6.4 and 6.5 are recognized in the standard deviation and sample variation of 'Culture & Personnel knowledge' and 'Risk Treatment'. From these tables, it is easily recognized that the 'Culture & Personnel knowledge' in the 'één ontwikkelproces' projects are more mature related to the non- 'één ontwikkelproces' projects. In addition, the sample variation of this aspect is increased in Table 6.5 and has a negative effect on the mean. On the contrary, 'Risk Treatment' is more positive in the non- 'één ontwikkelproces' projects and has a smaller difference in the sample variation.

	Policy & Strategy	Top Management commitment	Culture & Personnel knowledge	Risk Assessment	Risk Treatment	Monitor & Review
Mean	7.13	6.43	6.39	8.03	6.85	6.31
Standard deviation	1.53	1.34	1.11	1.03	1.71	2.02
Sample variation	2.35	1.79	1.22	1.06	2.92	4.06

Table 6.5. Mean, SD and Sample variation per aspect for all interviewees.

These sample variations are the highest for 'Monitor & Review' with a variation of 4.06. Followed by 'Policy & Strategy' with a variation of 2.35 and 'Risk Treatment' with a variation of 2.92. From this data, it can be

stated that the 'Risk Assessment' is most mature with a mean of 8.03. The most immature aspect is 'Monitor & Review'.

Figure 6.9. shows the differences between 'één ontwikkelproces' projects and other projects performed at Heijmans. The general interviewees score low in all aspects. Based on these and the previous results, it can be stated that the 'één ontwikkelproces' projects are more mature. This can be related to the aim of the 'één ontwikkelproces' to reduce the risks to align the three disciplines design, construct, and asset up front. However, as already mentioned, this is based on two respondents per project and must be validated by performing this data analysis by more respondents.

Figure 6.9. Interrelations between all interviewees.

Figure 6.10 and Figure 6.11 presents the results per respondent. The risk manager of the general interviewees (respondent 9) scored mostly the highest at every aspect. A limitation is the difference in interpretations due to new developments regarding risk management at Heijmans. The risk manager is highly involved in these new developments and has a different point of view as is based on the quote: "I look from a perspective of 2-3 years ago" by the general design manager. The risk manager has been working at Heijmans since 2015. At present, this is 2 years ago. At present, DE-risking is highly important. The difference results by the quote of the risk manager "DE-risking is the theme at this moment, but what we have done in the previous year's regarding risk management is not clear for me."
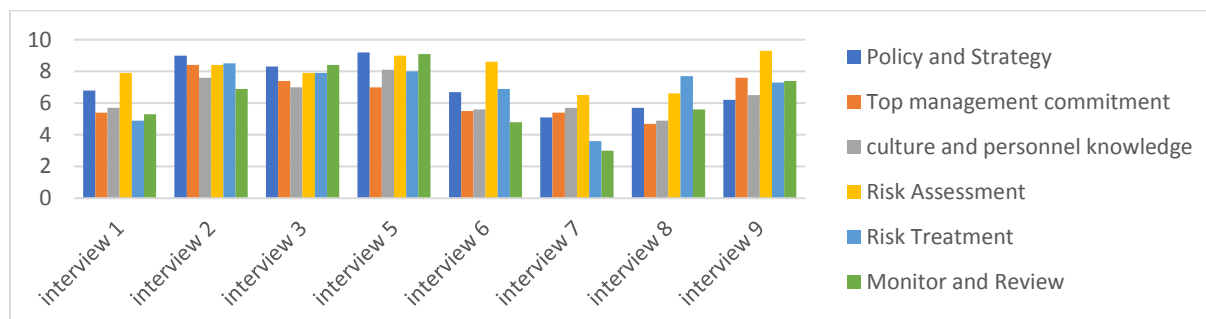

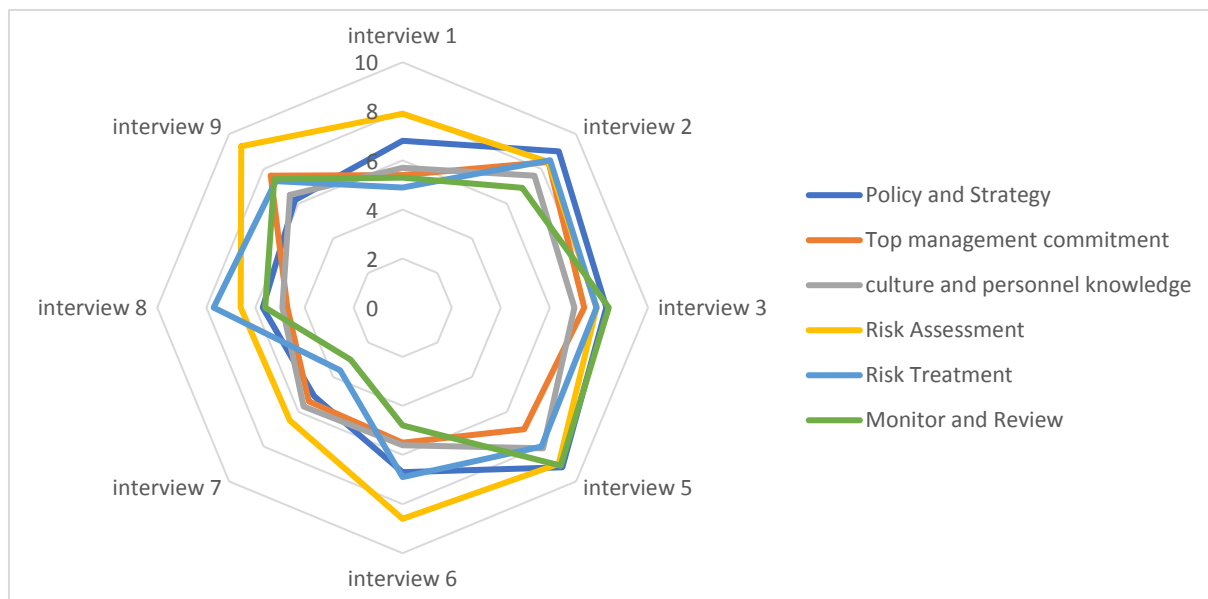*Figure 6.10. Risk maturity of all interviewees per aspect.*

Figure 6.11. Risk maturity of all interviewees per aspect.

The problem mentioned by the general risk manager is: "Where it is often about, is that people do it, it is in their heads. Since it is in their heads, it is hard to define if they do it properly. You do not know it. The first challenge is making risks explicit and the extent of making risks explicit. A large part of risk managers is trying to make these risks explicit". However, this lack of making risks explicit must be validated. The risk manager mentions this about other project members, but it is hard to appoint this problem as there is no data of the project members that confirms this. However, it can be assumed as a possible lack due to explanations of other respondents. For example, the design manager who mentions "Risk management is highly based on emotions. If a certain risk is recognized, and the previous time it failed, it is necessary to dive into the circumstances and why it went wrong. If you do not control it, then it goes back to emotions and experiences. It is good to examine what we have done and what was good." Besides, "unclear Relatics platform is what everyone prevents from updating risks. The more included in Relatics, the harder it is to get information out of the system. The system works, but you must be highly involved to understand it". Which is in line with the design manager of Project X. These are all explanations that appoint the lack of making risks explicit. In addition, in Section 6.1.1., 6.1.2., and 6.1.3. managers appoint the low level of implementation. In contrast, the quantitative data shows positive results based on the level of implementations of the statements. It seems that the qualitative data appoints this as a lack, but the quantitative data appoints it as improving the mature level.

For the design manager, the improvement is the change between tender phase and design phase. "In my opinion, this transition must not hold place. Stick to the plan. In earlier years, the tender team was not part of the design phase. People do not want to move to the design team and only want to do tenders. However, if there is no switch in team, there is more commitment since the plan is designed by yourself. Otherwise, the new team mentions that some elements are not possible and changes the plan." This is in line with the research of Van der Meer (2015) who formulated the differences in risks identified in the tender phase and the start of the construction, see Figure 6.12. The design manager also mentions "People have to feel ownership of a certain risk" as an improvement in the risk management process in practice. This improvement is already mentioned in the previous analyzed projects and can therefore be considered for further research.
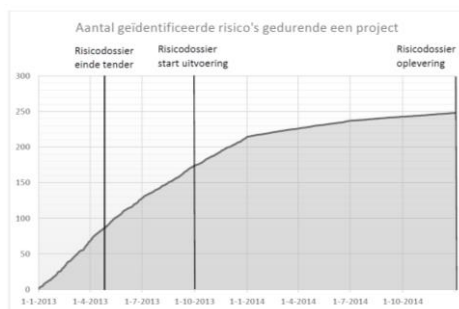
Figure 6.12. Example of the number of identified risks per phase (Meer, 2015).

Cross case analysis risk manager and design manager

Figure 6.13. shows all the results of the risk managers. There is no interviewee that is mostly positive or negative. The averages for the aspects 'Policy & Strategy', 'Top management commitment', 'Culture & Personnel knowledge', 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review' are respectively 7.8, 7.5, 6.5, 8.8, 6.4, 6.5.

The sample variations per aspect differ a lot, mainly in the aspects 'Top management commitment' (Δ = 4.6) and 'Monitor & Review' (Δ = 4.8). During the interviews, interviewee 1, 5 and 7 stated that pro-activity and commitment is really project and team specific. This quote validates the high delta within both aspects. The aspects with the lowest variation is the 'Risk Assessment' (Δ = 1.4). The 'Risk Assessment' is highly based on predefined processes like the risk dossier. The format of the risk dossier is well defined as it can be validated that the tools and techniques are well defined. For the other aspects, the delta differs from 2.6 – 3.1. Which means that the difference is one score level of the GRMM. As from the results, it can be stated that the aspects 'Policy & Strategy', 'Top management commitment' and 'Risk Assessment' are well organized based on the results of the risk managers. The aspects of 'Culture & personnel knowledge', 'Risk Treatment' and 'Monitor & Review' are less mature. 'Policy & Strategy' and 'Risk Assessment' are mainly based on pre-defined methods, tools, and techniques. As the three most immature elements are mainly based on the quality of performance.
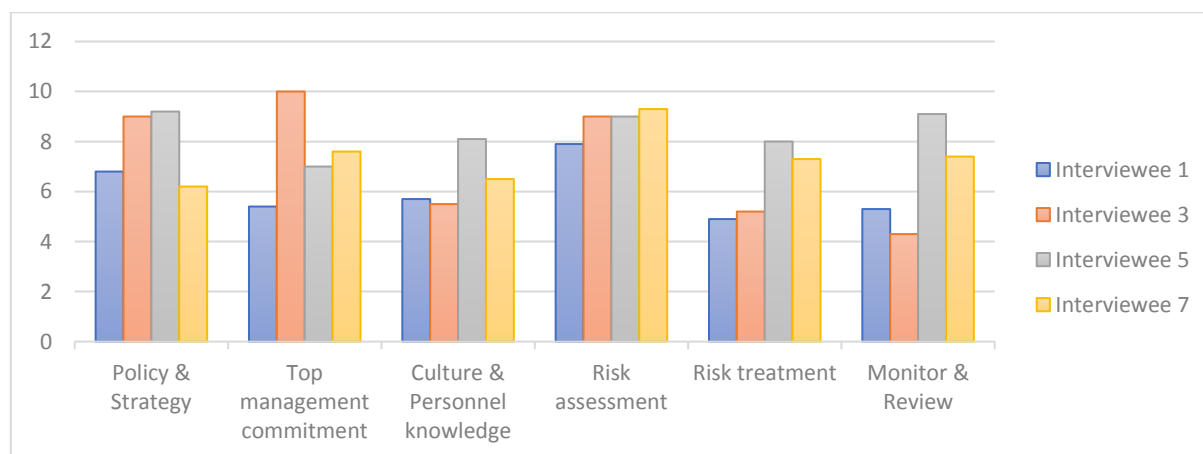
Figure 6.13. Risk maturity of risk managers per aspect.

Figure 6.14. shows all the results of the design managers. The design managers are more divided by their scores. Three interviewees scores below 4. The red, blue, and grey interviewees are mainly the three interviewees that score the highest. These interviewees are part of the 'één ontwikkelproces' projects. The averages per aspect are respectively 7.0, 6.3, 5.8, 7.6, 6.9 and 5.7. The deltas are higher between the design

managers as it is for the risk managers. The aspects with the highest deltas are the 'Risk Treatment' (Δ = 4.9) and 'Monitor & Review' (Δ = 5.4). The 'Monitor & Review' was also the highest delta by the risk managers, as the 'Risk Treatment' is different. The aspect with the lowest delta is the 'Risk Assessment' (Δ = 2.1) and is comparable with the data of the risk managers. The other aspects differ in delta from 3.7 – 3.9. From these data, it can be stated that the 'Risk Treatment', 'Risk Assessment' and 'Policy & Strategy' are well organized. The aspects that are immature are 'Monitor & Review', 'Culture & Personnel knowledge' and 'Top management commitment'.
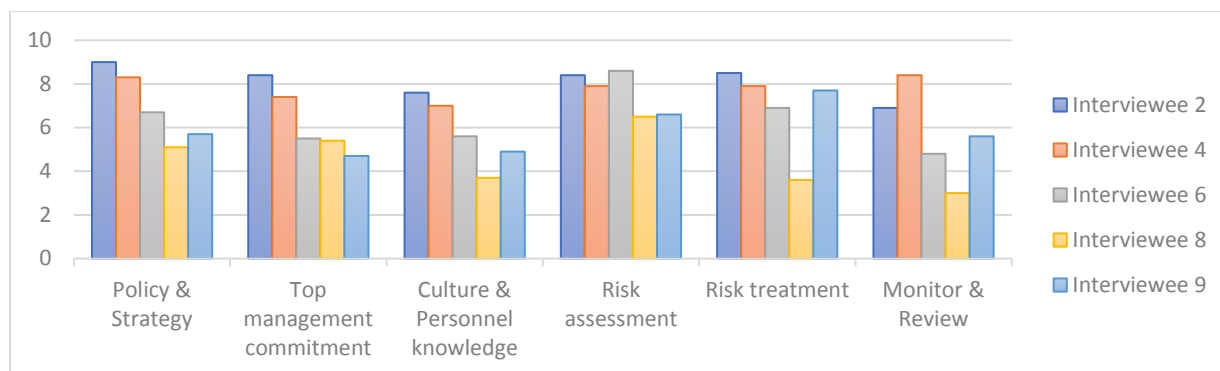
Figure 6.14. Risk maturity of design managers per aspect.

The outcomes differ as the risk managers state that the 'Risk Assessment', 'Policy & Strategy' and 'Top management commitment' are well organized and the design managers state that that 'Risk Assessment', 'Policy & Strategy' and 'Risk Treatment' are well organized. The difference is within the 'Risk Treatment' and 'Top management commitment'. The average of the 'Risk Treatment' of the risk managers is 6.4 (Δ = 3.1) as the average of the design managers of the 'Risk Treatment' is 6.9 (Δ = 4.9). The average of the top management commitment of the risk managers is 7.5 (Δ = 4.6) as it is a 6.3 (Δ = 3.7) for the design managers.

From both Figure 6.13 and Figure 6.14, the averages, and the small Δ it can be stated that the 'Risk Assessment' is the most agreed upon mature aspect by both roles. The figure of the risk managers gives no clear view about which project perform better on risk management, but the figure in which the design managers are shown, it can be clearly stated that the 'één ontwikkelproces' projects perform better risk management.

	Most mature	less mature	Highest delta	Lowest delta
Project X	Risk Assessment	Monitor & Review	Risk Treatment	Risk Assessment
Project Y	Policy & Strategy	Culture & Personnel knowledge	Monitor & Review	Policy & Strategy
Project Z	Risk Assessment	Top Management Commitment	Monitor & Review	Risk Assessment
General interviewees	Risk Assessment	Culture & Personnel knowledge	Risk Treatment	Policy & Strategy
Risk managers	Risk Assessment	Risk Treatment	Monitor & Review	Risk Assessment
Design managers	Risk Assessment	Culture & Personnel knowledge	Monitor & Review	Risk Assessment

Table 6.9. Overview of most mature aspects, less mature aspects, highest deltas and lowest deltas.

To wrap up, table 6.9 gives a clear overview of all the analyses based on the quantitative data. What must be mentioned is that the deltas are enormous high. A reason for this could be the division of scores between 0, 3, 7 and 10. One score different results in a delta of 3. Another aspect that must be considered for improving the less mature levels is the Culture & Personnel knowledge. Of all three groups that do not

mention the 'Culture & Personnel knowledge' as first immature aspect, it is ranked as second low aspect. The findings of the qualitative data are presented in Chapter 7.

6.2. Differences between guideline and practice

The analysis of the project risk management at Heijmans is based on quantitative and qualitative data. For identifying the differences between the risk management in practice and the Heijmans guideline, mainly the qualitative analysis is used since the quantitative data shows a high-risk maturity level of aspects within projects at Heijmans. To identify the improvement areas, it is necessary to identify the elements that are not (correctly) performed in practice while it is described in the guideline.

From the quantitative data, it became clear that the risk management in practice is mature. Especially the pre-defined processes and systems, which resulted from the maturity level of the aspects 'Policy & Strategy' and 'Risk Assessment'. In addition, Chapter 5 and qualitative data of Section 6.1 present the well-described processes since it is highly detailed and most of the elements described in the Evaluation Framework are included in the guideline. The risk identification and quantification is performed properly and top X risks are determined properly and documented to the client and senior management.

However, all risk maturity levels presented a mature level with a range between 6 and 8. Therefore, it was necessary to dive deeper into the data with a critical view to search for the smaller elements that cause problems for the performance of risk management in practice. While conducting the qualitative analysis, the bottlenecks within the risk management in practice became clearer. It seemed that regarding respondents some of the project members did not perform risk management in practice properly, in contrast, some were highly involved with risk management. While performing risk management, the iterative process in which control measures are identified, implemented, evaluated and in the end the process is monitored is not done or not done in a sufficient way. Quantitative data shows in the aspect 'Risk Treatment', 93 statements filled in by respondents. As explained in Section 3.3, this aspect is related to control measures. 27 of these 93 statements is ranked with a 0 or 3 which means that almost 1/3 of the control measures is insufficient. Also, the risk manager of project X stated: *"We do have control measures, but it is not explicitly based on strategies. … If someone thinks about the risks and what we can do with these risks, I do not see an additional value of explicitly mentioning it."*

In addition, as described in Section 6.1, the control measures are not implemented in the way it is described in the guideline of Heijmans. For the evaluation, the following is mentioned in the guideline 'The risk will be evaluated by the risk owner based on the feedback of the action holder'. From Relatics, in which the risk dossier is described, an empty risk evaluation column appears which means it is not filled in. It could be that the risk evaluation is performed, but not documented properly within the system. For this reason, it can be assumed that there is a lack of risk response. While it was not properly mentioned by all respondents within the qualitative data, additional desk research in Relatics validated this lack. The risk control plan is not aligned with other risk maturity levels. In the Heijmans guideline, risk control includes the steps 'Implement control measures', 'evaluate control measures', and 'monitoring the process'. In the guideline, more attention was paid to the risk control part. However, in practice, more attention is paid to risk identification, risk quantification and defining control measures. Regarding the guideline, control measures and their evaluation should be recorded within the online platform. In practice, no fulfillment is given to this risk control. The implementation of control measures is mainly experienced and feeling based and not based on strategies. No continuation is given to the evaluation of control measures after implementation.

Moreover, the guideline describes that risks should be discussed in the management team sessions. From qualitative research, it became clear that these are not always part of the sessions. Some respondents

stated that it would be beneficial if risks were discussed every week in those sessions or if the risk manager would be part of these management sessions. Elaborated by other respondents, mainly the Top 3 or Top 5 risks were discussed in management sessions and the state-of-the-art of those risks.

Additionally, the guideline of Heijmans points clearly the step instructing the project team which is highly of importance. Nonetheless, a lack of knowledge about goals and strategies of the risk management process were highlighted in qualitative research. Four of the respondents ranked this as insufficient. Besides including the communication of goals and strategies, this step can also be interpreted as receiving training at the beginning of the project. But this statements also ranks insufficient, which became clear from quantitative data in the previous sections in this Chapter.

The statements included in the GRMM are based on theory. Mostly of these statements are properly and sufficient implemented within the risk management process of the contractors' organization. However, a small amount of statements can be upgraded, these statements are mentioned on page 53-54. Page 53 also elaborates the amount of statements related to communication. Analysis of the projects in section 6.1.1., 6.1.2., and 6.1.3. show the amount of statements related to communication. However, within the guideline of Heijmans, no clear elaboration is given due to communication. What is formulated, are the meetings every month, and quarter. The reason for the low level of communication could be that only the higher management levels are involved in these meetings or meetings could be cancelled since other meetings or tasks are prior to perform.

6.3. Conclusion to what extent risk management is carried out in practice

What is the current risk maturity situation at Heijmans?
From quantitative data, the conclusion can be drawn that the risk management process in practice 'Risk Assessment' is most mature within the contractors' organization. Since it has one of the lowest deltas (1.08), this result is reliable. This aspect is followed by the high maturity of 'Policy & Strategy'. In contrast, this aspect shows a higher delta (2.35). Most of the results show a large delta, the reason for this could be the large difference in ranking scores since only the scores 0, 3, 7 and 10 could be filled in. However, both mature aspects are related to the tools, techniques, and systems. For the 'Risk Assessment' aspect, Relatics is used as a system to manage the risks. This system is a format to identify risks, decide the action holder, control measures, and evaluate the control measure. The 'Policy & Strategy' aspect is based on the pre-defined processes. The aspect that scores less in risk maturity in most analyses is 'Culture & Personnel knowledge'. This aspect is not in every analysis the lowest, but is always included in the two lowest ranked aspects. Since it has the smallest delta (1.22) it could be stated as reliable. The other low ranked aspect differs per project. When Tables 6.7 ad 6.8 are considered, the aspect 'Monitor & Review' has the lowest average, however, it also has the highest delta which relates to a less reliable outcome since the respondents differ a lot in ranking. All respondents show a mature current risk maturity level at Heijmans. Since most of the results are in a range of 6 – 8, room for improvement is present.

What is the difference between the Heijmans guideline and the risk management in practice?
The guideline of Heijmans is compared to how risk management is performed in practice. These differences are mainly based on the project steps due to the elaborated process in the Heijmans guideline. In addition, the data gathered from the risk management in practice is based on the statements defined from theory. The largest differences occur in the following parts.

Quality of risk control performance can be improved in Part C. This can be improved by first, an implementation of control measures based on strategies or pre-defined formats. At present, this is mainly experienced- and feeling-based. In addition, mostly risks are reduced, without considering other risk responses by making decisions. Second, evaluating the control measures. As can be seen from Figure 5.1, the risk evaluation column is empty within Relatics, while the deadline is already passed. By giving continuation after implementation of the control measures, more data can be gained about how risks react on the chosen control measures. This could lead to a database in which lessons learned can be adopted based on the evaluation of the control measures.

> *"I am already satisfied if someone is able to mention the control measures."*
>
> – Risk manager at Heijmans

Inconsistent implementing risks in the management sessions. As stated above, this is project specific. It is described in the guideline of Heijmans, but is not always consistently implemented and conducted. This difference is detailed due to the critical view on the process. As mentioned, the level of maturity is high at Heijmans and small differences are also of additional value to highlight in projects.

Insufficient instructing the project team members in risk management in practice. Both statements about receiving a training and communication of the goals and strategies could lead to the lack of instructing project team members. In addition, no respondent mentioned this process step.

Insufficient level of communication and documentation in risk management in practice. The statements from the quantitative data presented a high amount of statements within the communication that show a low risk maturity. In addition, the low aspect 'Monitor & Review' validates the lower level of quality in documentation.

Risk management in practice probably includes more elements than appointed by the GRMM. However, only the statements from theory within the GRMM are tested within the contractors' organization. Therefore, it is hard to compare the elements implemented in practice and not mentioned in the model since the statements in the model were leading for gathering data.

7. Results

This chapter presents the results based on the case study conducted at Heijmans. The results extracted from practice are based on the link between the quantitative and qualitative data (See Figure 7.1.). The information used for these results are given in Section 6.1. The relevant information of the explanations is analyzed. This relevant information is the main input for identifying the cause why certain statements within the aspects are mentioned as less mature. The findings presented in this chapter show the probable causes, based on the quantitative and qualitative data of the interviewees in 'één ontwikkelproces' project.
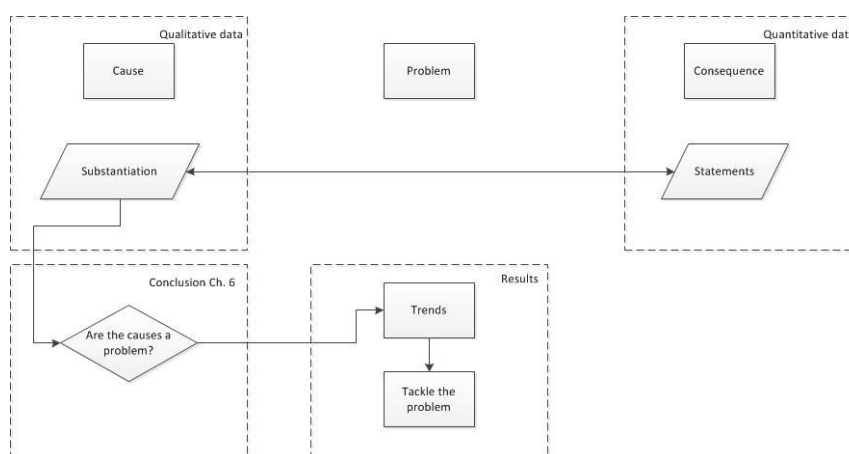
Figure 7.1. Relation gained data and result steps.

7.1. Results from practice

In general, the projects at Heijmans are well-performed, this means that all projects are mature based on the quantitative data of the respondents. Heijmans has well organized systems and guideline which results in a high maturity of 'Policy & Strategy' and 'Risk Assessment'. Especially, the respondents agreed upon the 'Risk Assessment' as the score variations were lowest for all aspects. However, things can always go better as seen from the ambition level of the respondents. In addition, the scope of this thesis is on how to improve risk management, therefore, mainly the less mature elements are appointed and considered for further research.

In general, the quality of performance of risk management in practice can be improved (p. 40, 45, 48, 51). This resulted from the explanations that risk management is based on experience and emotions (p. 39, 49). Mostly, risks are identified and controlled implicit (p. 39, 40, 45, 46, 48) and evaluation is not done. Moreover, some are wary to talk about risks, to be complete (p. 44) and have no proactive attitude (p. 39, 40, 44, 46, 50). The risk manager should have a proactive attitude at these moments since there are people that prefer to not discuss risks. Their active risk attitude must be improvement (p. 40, 41, 44). The elements that are mentioned as bottlenecks for making risks more explicit are summed up.

First, risk management is looked at as an **additional tool**. Additional tool is considered as the risk management and Relatics (explained in Section 5.1.). This finding is based on the explanations about the

threshold of using Relatics (p. 41), the additional time needed for risk management (p. 41). This additional tool is recognized by project team members (p. 41), but also by risk managers who have a combined role with System Engineering (p. 39, 40, 41). Risk management is not part of their core tasks and receives not the attention that it should receive.

Second, project members are **unfamiliar** with the risk management processes. The requirements of the contract are achieved. However, within the risk management approach there is a lot of freedom left (p. 56). Besides, processes are new since it is a DBFM contract and highly complex (p. 44, 45). In these projects, it is required to have a consistent or uniform approach that is SMART defined (p. 44). The processes are described at a high abstract level. For people that are not familiar with these processes it is hard to identify the processes and what is exactly expected.

Third, **no clear overview** of roles and ownership within the projects. As mentioned by both general interviewee and the design manager of Project Z (p. 49). Changes within the organization structure leads to an unclear organizational overview. It is hard to communicate about risks if it is not clear who is responsible for what. In addition, information gets lost.

Fourth**, busy with their own complex tasks**. At page 44 is described that the complexity leads to several problems within the project. Some of these problems are already mentioned by the unclear overview. First, the amount of communication that is involved, this requires a lot of burden for your own work. Second, the DBFM contract in which the content of the tasks can slightly differ from the previous tasks.

Fifth, **less ownership**. Ownership or responsibility often came back (p. 39). At present, it is one of the attention points in the whole organization of Heijmans. The problem is that people do not feel responsible for certain risks. A positive point mentioned in Project Z is 'naming and shaming'. The risk manager told "with naming and shaming, an element is linked with a person. In this way responsibility grows". If a certain name is linked with a task, people make sure the task is performed well.

Sixth, **less risk awareness**. The insufficient level of risk awareness is mentioned at page 40 and 45. First, "We do it in an implicit way, not explicit. The question arises if they are aware of their risk attitude. The risk manager must have a proactive attitude and ask for risks in the field. The reactive attitude must be changed to proactive attitude." Second, "There are some people that are risk aware. People will visit me and discuss their risks. But there is a clear separation per team. Within the design team it could be the time pressure that results in discussing the risks afterwards. Within the construction team it is much better, maybe because they are more physically involved with risks. The difference between the design and construct team is high." Third, "the whole experience: the awareness within the team. How everyone is involved in risk management." Fourth, "The management team is risk aware, however, the levels beneath them are less risk aware." Fifth, "all in all, the culture and personnel knowledge is positive at Heijmans. The mind-set boundary is at the drawing. Also in drawings there is a difference between a real designer who is less risk aware compared to the execution/construction organization. They think more about the safety of their employee."

Seventh, **risks are no part of the management team sessions**. One interviewee stated that given risks a better platform within the management team sessions is of additional value.

Eight, **unclear risk process**. First, the performance of the management team is based on commerce. As they make sure the project plan fits in the contract requirements (p. 45, 48). Besides, it is said that the unclear process is based on not SMART defining goals, strategies, and approaches (p. 45). Besides, every risk management plan is done differently per project. This results in a not uniform approach which can be hard

for project members to understand. "They have troubles with identifying the abstract level of risk management" (p. 45). In addition, "a better communication about the process elements is necessary.

Ninth, **no clear document overview**. The integral design manager mentiones the presence of the documents but it is not clear were to find them if a certain elements is searched for. Besides, the risk manager of Project X clearly mentions the burden of implementing all different documents in Relatics (p. 40, 41). He substantiated that several people make their own documents since they cannot find the right documents. The risk manager must update Relatics with all these documents.

Tenth, the risk management process is a **burden**. Due to time pressure, risk management is not performed and seen as a burden since it is an additional task. Besides, also for risk managers it is an administrative burden. This results in not up-to-date documents as it lays for a while. Another interviewee mentioned:

> "The biggest challenge is to keep everyone motivated."

7.2. Validation

The findings of the data analysis are based on 9 interviews of risk and design managers in the field. By combining the quantitative data and qualitative data, the root causes of making risks explicit resulted in Chapter 7.1. The validation of the findings has the aim to discuss the identified nine root-causes of risk management in practice. Qualitative research can be validated based on four strategies (Klenke, 2008): construct validity, internal validity, external validity and reliability. The validation in this research is performed as an internal validity. This internal validity is used for mainly explanatory or causal studies (Gerring, 2017; Swanborn, 2010; Yin, 2014). Validity is necessary to determine how presentative the results are in reality (Silverman, 2011).

The findings have been validated by three experts of Heijmans. One of the experts is helping the CRO of Heijmans to improve the risk management within the organization and has 16 years of work experience at Heijmans. The second expert has a 5.5 years' work experience as a risk manager at Heijmans. The third expert has a work experience of 2.5 years at Heijmans. The last two risk managers have improved the risk management processes within the projects extensively in the last years. One validation session is given in which all three people were involved. The results where explained and a small questionnaire is done on if they recognize these causes.

The validation session was done based on the findings that are presented in Figure 7.2 in Chapter 7. First, a short presentation was given about the structure of the research and how the findings are generated. The question was asked if the three experts recognized these findings within the projects as X that leads to Y. Y is the insufficient level of explicit risk management. For all these findings, the experts had to rank the finding from 1-5 to range the statements based on the level of importance to improve within projects. One is less important and five is highly of importance to improve. The expert at director level could not rank these findings as it was too focus on projects.

How much weight has a certain cause and are there any other causes that are of importance and not included in Figure 7.2?

As two of the experts mentioned:

"The elements with the highest weights are ownership and additional tool. If people feel the responsibility (ownership), the rest will follow. People will accept the time needed, and the vague communication structure will disappear."

Unfamiliar with processes

The processes are unclear and complex for project team members. These processes are not their own processes, that is the most important thing. The processes are there to have a well functioned team behind the projects. But than a BPS department comes and tells about how processes should be done since it is mentioned at the BPS platform. Maybe it is an option to let them create their own processes.

| 3 |
| 5 |
| 2 |

No clear overview within the project

The experts mentioned: "the basis of the processes we design, is based on how we think the process should go. If we create a risk management process, we will not ask the design manager what kind of risks they pass." The expert at director level mentioned: "It would be preferable to create a work group with (about) 10 employees across the whole organization. Than you will ask what their top 10 risks are and how they can prevent this. At present, all these processes are not included since the people at management level design these processes." This explanation of the experts is highly related to the risk awareness, unfamiliar with the processes, unclear risk process and no ownership.

| 2 |
| 2 |
| 2 |

Busy with own complex tasks

"People are not aware of the complexity of projects. They do not understand what the effect is of changing an element. Estimation of this effect is hard and they think they can fix it by themselves. This is highly related to the integrality finding. Everyone is busy with their own tasks and thinks everything is thought about. But there is a whole circle of other people that are influenced by that person. For example, if Heijmans Wegen earns 300.000 euros, and another department spills 800.000 euros due to the change of Heijmans Wegen, the sum is -500.000 euros.

| 4 |
| 4 |
| 4 |

Tasks can be so complex that they will stay in their own box. They make sure that this box is performed well since they do not know what the rest is about due to the size of the project. It is too complex for their mind. And do what the boss tells them to do."

No ownership

If they are not risk aware, they will not feel the responsibility (ownership). The risk manager must appeal the design manager with the question: 'now you created a solution, but what kind of risks are related?' If he never receives this question, the design manager will proceed a risk that can be avoided. Heijmans receives the impact of that risk, and he as well as he is part of the organization. That is the risk of proceeding risks that you do not understand.

| 4 |
| 3 |
| 5 |

Ownership is related to the complexity and clear process, if people do not understand the process, they will also not feel ownership. You should start with the project end responsible. The person who understands all the processes. What can be improved, is also make clear from the higher levels in the project who is responsible and division of tasks. How to deal with it and how it is controlled.

Not risk aware

Related to 'No ownership'. Besides, it is about creating a risk culture. The experts mentioned "if the manager says we have a risky project, and mentions 'we want to receive this from you', or 'you have to do this'. It does not help by creating a risk culture. If from the beginning it is communicated there is enough contingency in a project and they do not want to take too much risks. Than they will spread the word.

| 2 |
| 1 |
| 4 |

Risks are not part of the top management sessions

For one of the experts it was not recognized.

"Normally, at the projects I work at, only the top 10 is discussed in the management team meetings. At none of them, the risks were not part of the management sessions. In the 'Deelmanagement plan' document (elaborated in Section 5.1), is described that it must be part of it. In the 'Voortgangsrapportage', the top 10 risks must be mentioned. This is what I use for these meetings. When large risks occur, I will mention it in the sessions. These sessions include all management team members." However, the other expert recognizes this finding in other projects. It can be concluded that every project has a different approach. The other expert recognizes it as an additional session that must be planned to discuss the risks.

n.a.
n.a.
3

Too unwieldy communication structure between risk owner, risk manager and action holder

Not elaborated on.

1
n.a.
2

Unclear risk process

See also the discussion of 'unfamiliar with processes'.

One expert recognized that risk management is something between the risk manager and management team. He mentions "I am not surprised that the constructor things the process is vague. It must be guarded that it will not happen that the risk management communicates with the design manager and the design manager will sit in the chair and list the risks that he thinks or expects in the project. Instead of communicating with the team behind the manager. This is validated by what the general design manager interviewee stated: "As part of the management, I am wondering how often the management team goes to the project teams to ask for risks. It is important to ask what their issues are. We should spend more time to these issues. If you go to their project teams, the project teams will also come to you as management."

2
n.a.
2

Additional tool

Not elaborated on.

4
n.a.
4

No clear documentation overviews

Not elaborated.

3
n.a.
1

Burden

Not elaborated.

5
n.a.
2

Other elements that effects the risk management process?

    1.   *No explicit profit feeling of mitigating risks (celebrate successes)*

"There is less space to share the successes of mitigating risks in projects. If a risk is mitigated, everyone goes further with the project. No one has the feeling of achievement. This can be referred to commitment, and results in lack of motivation." The other experts discussed "you are at the wrong side of the profits, you cannot make it commercial. If you have mitigated a risk, you have earned 10 million profits for example. But it is cutting on the lower side."

2. Lack of challenges when the process is designed: lack of motivation for extra reflecting

Another element that was elaborated is the lack of challenges when the process is designed. "it is not that people say, 'oh yes, we have every month a meeting about risks and we will check the whole list again'. This lack of challenges can result in a rut. Sometimes it is a kind of a game to go through the risks as fast as can without thinking about it. This is about ownership. However, it is your own work, your own hygiene. If I be part of the meetings, they will elaborate and think more about these risks."

3. Insufficient transparency about not included risks

"The people that are involved in risk management are the constructors for example. The project team members: the people below the manager. The project manager should know what kind of risks they take, and if he does not understand these risks, he must have an opinion about it. For example, 'I cannot explain why the team took the risks' and has to be transparent about it."

4. Jeopardy of proceeding risks that are not necessary to take

This is in line with the elaboration of element number 3: 'Insufficient transparency about not included risks'.

5. Projects are complex, but people are insufficient aware of the complexity or underestimate this complexity.

This is in line with the already mentioned statement: 'Busy with own complex tasks'.

Analysis and observations
From these discussions, the conclusion can be drawn that several causes are highly related to each other. Therefore, the causes can be brought back to a smaller number of findings. The findings that can be combined are: the risk awareness, unclear risk process, unfamiliar with the processes and no ownership. Besides, unclear risk process, unfamiliar with processes and complexity is highly related as became clear in the conversations. In addition, ownership, complexity, and clear process are highly related. The risk management approach is project specific; therefore, it is the risk managers responsibility to include risks in the management sessions. The too unwieldy process structure by risk manager, risk owner and action is highly related to the explanation the risk owner must feel the ownership, the responsibility to ask the team behind him. The experts agreed on the burden that project members see, the additional tool and no clear documentation overview but did not elaborate on this. The complexity of projects is highly related to integrality as shown in the reactions of the experts.

A difference can be made between project specific and with the findings that are also recognized at organization level. The weight is in how much they think it is an element that causes implicit risk management within the project.

Project and organizational level (average of 3 experts)		Project level (average of 2 experts)	
Unclear processes	3.3	Risks are not part of the management team sessions	1.5
No clear overview within the projects	2	Too unwieldy communication structure	1.5
Busy with own complex tasks	4	Unclear risk processes	2
No ownership	4	Additional tool	4
Not risk aware	2.3	No clear document overview	2
		Burden	3

Table 7.1. Overview of the weights of level of causes within the project.

These statements are highly related to each other as they say: "You want the management team to act risk-driven. So, you should embed it more in the design sessions, construction sessions, or work preparation sessions. In this case, the sessions become more risk-driven. This is in line with the risk manager of project X who mentioned "At present, it must flow from the CRO to the lower levels". From the new findings, the lack of motivation of the project team is also recognized in Project Z. The design manager stated that the biggest challenge is to keep the project team motivated.

7.3. Conclusion

The validation session concluded that the findings must be revised. The finding ´risks are not part of the management team sessions´ is not always recognized in projects. It depends on how the project is established. As it is mentioned in the 'Deel management plan', it is not always part of it. Moreover, the following findings should be implemented: 'The lack of celebrating an achievement' and 'lack of challenges when the process is designed'. The following additional causes are kept in mind: 'Insufficient transparency about not included risks' and 'Jeopardy of proceeding risks that are not necessary to take'. Since both elements are at a specific level and not fit in the findings framework. The rest of the findings are all related to each other, therefore, it is necessary to revise these findings. The four factors that probably have the highest influence on risk management performance are: additional tool, risk management as a burden, lack of ownership, and complexity of tasks, presented in dark blue in Figure 7.2. The left box are the most abstract findings from the interviews and the GRMM. The right box are the findings based on the qualitative analysis and the validation. The dark blue findings are the elements that are more of importance based on the validation. These factors have a higher influence on the risk management performance.
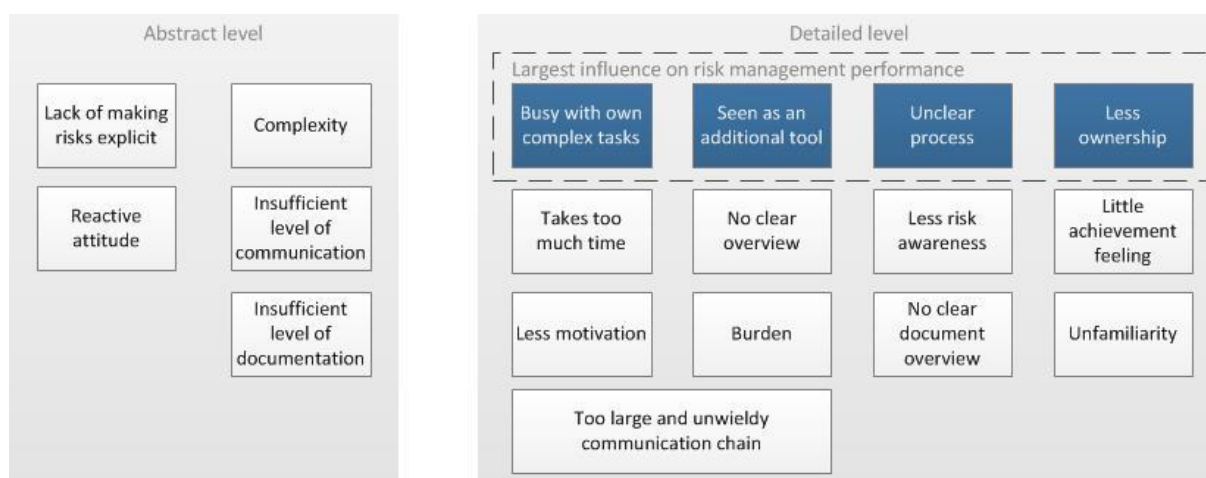

Figure 7.2. Overview findings after validation.

PHASE IV – Discussion

The Discussion Phase consists of chapter 8 and 9. Chapter 8 includes the discussion of the model, discussion of the findings, implications in theory and practice, and limitations of this study. Chapter 9 contains the conclusion and recommendations for Heijmans, science and the model.

8. Discussion

The discussion chapter includes a discussion of the model and the findings related to the differences between the Evaluation Framework, guideline of Heijmans, and risk management in practice. In addition, the implications in practice and science are discussed and finally, the limitations of the findings and used model are formulated.

8.1. Discussing the model

The model is designed based on literature and includes statements about how risk management ideally must be performed. In this way, ideally risk management in theory is compared with risk management in practice. This results in to what extent projects perform these best-practices. The model has the aim to identify the strong and weak elements in the risk management process in an organization and/or project. Originally, this model is built based on HoogWaterBeschermingsProgramma's (HWBP). But in this thesis, two road infrastructure projects and a rebuilding project of a sewage treatment are evaluated. Therefore, the question arises how reliable these strong and weak elements are? Firstly, it is discussed whether the mentioned best-practices are applicable for all phases in different construction projects. Second, what are the differences from practice that should be implemented within the model? Third, is the division of the organizational area and application area representative within practice? Fourth, when are the results reliable?

First, the best-practices mentioned in the model should be discussed. 51 statements are designed in which best-practices are included. However, to identify the differences in the design phase, it is not possible to select the best-practices related to this design phase in the model. For example, the statements about the risk appetite are ranked low by several respondents. The risk appetite is performed in the contractors' organization in the tender phase, the phase before the design phase. Within this tender phase the decision is made if the contractor can perform the project based on riskiness. First, risks are assessed to identify the riskiness of a project and second, a decision is made if this level of riskiness is acceptable for the organization. In addition, Monte Carlo Analyses are conducted in this early phase. These statements based on risk appetite are performed, but not in the design phase. Is the risk management process performed poorly in the design phase? Or is it a shortcoming of the model that does not specify and divide those phases? An explanation could be the iterative process in which risk management should be performed.

However, explained by respondents, if the contractor wins the tender, the contractor has no other choice than to build the project, with a limited amount of exceptions. If it is assumed that the respondents have the steps earlier made in the tender phase in their minds, the following could refute this. Often, there is a switch between teams when the tender phase is finished and the design phase starts. It is likely that information about the risk management process gets lost. How does the model react on these differences within the team? And how does it react to the different phases in a project? It could be that these teams, functions, or roles switch only in contractors' organizations. But, it is likely that this model is applicable in all construction projects. Ideally, the best-practices included in this model should be suitable for all construction projects and all phases individually. To make a division between phases in the model, organizations could determine their risk maturity within every phase in different types of projects.

Second, some best-practices defined in literature are not included in this model. Theory elaborates on the importance of making risk management an integral part of project management. Qualitative data presented explanations that can improve the alignment with project management process. For example, making statements SMART, perform risk management uniform, unclear process and risk management is an additional tool. These explanations were mainly elaborated by design managers, who could have other expectations than risk managers. It is possible that different needs occur within project teams. For example, design managers who seem to be more result-driven and risk managers who seem to be process-driven. At present, it seems that the model only focusses on the risk management process which only risk managers can fill in since they have the knowledge.

However, what resulted from Project Z, is that risk managers are satisfied with their own process and skewed results could occur. Is the risk management process performed in a mature way? And what is mature? Is maturity the level of performing risk management? But theory states that risk management should be integrated. Is mature the level of integration of risk management in the project? Or what do these results say? If risk management maturity is the level of integration with project management, it could be of additional value to include more best-practices about the integration of risk management in project management since more people within the project are involved with this process. If maturity in this model is based on only the risk management performance, what do these results mean since it is stated in theory that it must be integrated with project management and cannot just be added to the project management process.

Two critical success factors from literature that could be of additional value to implement are 'The owner should take an interest in the performance of the project, due to complexity, it is necessary to have a division of roles and responsibilities among specialized players' (Beckers & Stegemann, 2013). From practice, it became clear that less ownership was a factor that could have a negative influence on the quality of the performance of risk management in practice. Besides, 'Making statement SMART' (Jugdev & Müller, 2005) is necessary to communicate properly within the project.

Third, the two areas in which the aspects are divided were not always representative. Within the contractors' organization, 'Policy & Strategy' and 'Risk Assessment' were highly related to pre-defined processes and systems. The organizational area in the model includes the aspects 'Policy & Strategy', 'Top management commitment' and 'Culture & Personnel knowledge' while the last two aspects are more based on the organizational project environment. The organization area seems to have a too abstract name, while the statements are detailed. This resulted from the outcomes of the mature 'Policy & Strategy' and 'Risk Assessment'. Further analysis appointed the processes and systems, both aspects are part of another area but highly related. Both aspects are related to the risk management in an organization or project.

Fourth, the model takes the point of view from the respondents about the risk maturity level quantifiable. To what extent can be stated that these quantifications are reliable and representable for the project? In which bandwidth are the results of the model representative? And what should an organization do when a low risk maturity level appears? Is it necessary to implement all low mature statements? The aim of the model is clear and it gives organizations a clear overview of the current situation. But how should it be applied?

8.2. Discussing the results

The results discussed in this section are based on the results of the differences between the Evaluation Framework and guideline of Heijmans, the guideline of Heijmans and risk management in practice, and individually about risk management in practice. The findings of the differences of the above and the factors

that could have a (negative) influence on the risk management process in large infrastructure projects are presented in Figure 8.1.
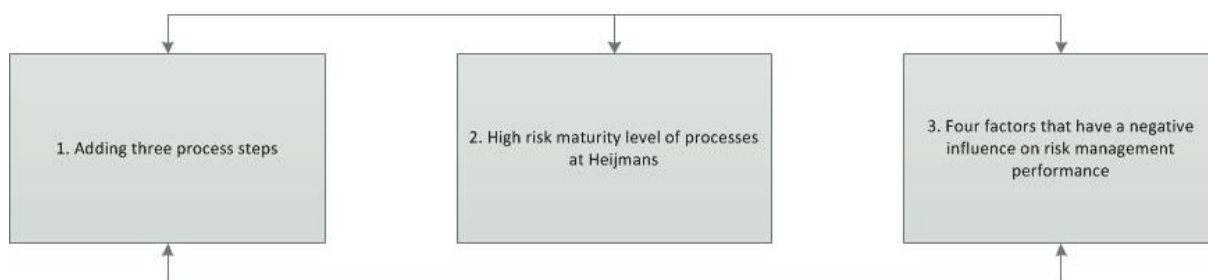

Figure 8.1. Three main findings.

At present, risk management is already designed and implemented sufficient. Quantitative research presented a risk maturity level mainly within a range of $6 - 8$. These levels show room for improvements to make risk management a more integral process within projects. But the question arises if the shortcoming steps should be added to improve the risk management process or should more attention be paid to the quality of risk management performance? This contrast is discussed. This contrast is discussed on three levels and will be elaborated in this subsection.

First, a discussion arises between result 1 and result 2: adding steps and a high-risk maturity level of the current process at Heijmans. The three large differences that could be added in the process are discussed: adding context, adding risk response plan, and adding low ranked statements.

Context. To make risk management a more integral part of project management, it is necessary to focus more on the context in which risk management is performed (Nicholas & Steyn, 2012). At present, the focus is mainly on the risk management plan in which risk management actions are described. This plan is implemented in the project management process at the beginning of the project and should focus more on the context up front, before it is implemented in the project management plan. With a larger focus on the context, mainly the organizational and strategic context is considered. But is it necessary to add context since in all projects, since hardly any large risks were exposed due to a shortcoming in the context? While focusing on the organizational context, responsibilities and ownership could be properly divided and mentioned SMART. Within Project Y, it was mentioned that naming and shaming worked well. In this project, naming and shaming was conducted as linking a person to a certain object. This person is responsible for the design and processes regarding that certain object, for example a bridge. If risks occur or control measures are not implemented sufficiently, a certain person can be hold responsible. The strategic context can be of additional value to align project goals and objectives properly. This alignment could reduce the level of abstractness (mentioned as negative influence on risk management performance) while making it consistent with the risk management plan. Project members would understand the process better as they become more familiar with the process. However, it could also lead to additional work that is not in line with the goal of the project.

Related to the environmental context, an environment manager is included in the project team, who is responsible for the environmental risks. A stakeholder analysis is conducted in the tender phase of the project; nonetheless, these stakeholders can change during the project due to the dynamic environment. For example, during execution of the project, a badger is found. The foundation for badgers will block the action of preparing the soil before building a road. This should be considered within the risk dossier, as it will have an impact on the time delay and therefore the project economics. Therefore, it seems to be of additional value to consider stakeholders that could influence the project economics continuously.

Risk control. Lack of post-project review and insufficient level of risk control performance are both related to risk control. The risk response is clearly described in the guideline of Heijmans. What became clear from practice, is the insufficient level of giving fulfillment to implementing the risk response plan. The post-project review is not mentioned in the guideline of Heijmans. But would implementing the post-project review help improving the risk management process? Literature states that diving into other projects, looking to best practices and communicating with other projects is a success factor in projects (Jugdev & Müller, 2005). Moreover, would improving the quality of risk control performance also lead to a better risk management process? If the qualitative data can be assumed as representative, the control measures are performed implicitly. The additional value of making risk control explicit should be examined. It is likely that making risks explicit results in a better risk control in which risks can be managed properly. From quantitative data, it appeared that no lessons learned are recorded, which can be interpreted as a shortcoming in documenting risk control actions and a shortcoming in documenting the reaction of risks to the control measures.

Statements. The low ranked statements mentioned in Section 6.1.4. are mainly statements that are an addition to the existing process. Seven of the ten mentioned statements should be improved at higher levels (management team and/or risk manager) within the project. These statements are:

- There is an experienced team/person responsible for risk management,
- Lessons learned (occurred risks, performing risk management, etc.) are recorded,
- Management uses risk management reports to make decisions,
- Management defines roles (with authority and accountability) to perform risk management process within the project,
- The whole risk treatment and mitigation process is based on the project risk management process,
- The procedure for deciding risk reservation is based on the defined risk appetite of the project, and
- The contractor risks, identified by the client, are communicated to the relevant contractors.

It seems that these seven statements must be implemented to upgrade the process. However, from scores of the respondents and looking at the most mature aspect scores it assumed that the process is mature. The question that is necessary to ask is: is it necessary to implement those additional elements as the maturity level is high? However, an additional research should be conducted to identify if it necessary to implement. From these respondents, it seems that they agree upon the process. However, will the result be the same if more interviewees were considered?

Second, a discussion based on the result 2 and 3: a high-risk maturity level of the current process at Heijmans and four factors that influence the quality of risk management performance. The presented quote gives a proper overview of the result of this thesis. This quote is substantiated by quantitative and qualitative data. Within the analyzed contractor's organization, 'Policy & Strategy' and 'Risk Assessment' were high in maturity. The high maturity of these aspects is related to the well-described risk management process and well-designed system to manage risks. But what is well-

> "The risk dossier and assessment are well designed. However, this process can be perfect but if no one gives these processes fulfillments, you still have nothing."
>
> – design manager Project X

designed and well-described? Quantitative data shows this high maturity, but it seems that the qualitative data appoints the bottlenecks. How serious can this data be interpreted? Are the qualitative results used to upgrade the process from, for example, a 7 to 9 or are they all large bottlenecks? In which quantitative

data and qualitative data show a large contrast. Or is risk management in practice so hard that less fulfillment can be given to these well-described and well-designed processes and systems? Both questions are elaborated in the following paragraph.

Within the examined project organizations, two levels can be appointed regarding result 2 and 3. On the one hand, the top management level, and on the other hand, lower levels in the organization. If the gathered data can be assumed as representative. The top management level designs the processes and systems, implement it in projects and make decisions. The lower levels (project teams) perform risk management and determine the quality of risk management performance. What resulted from research is that there is a high maturity in top management level and insufficient maturity in the lower layers within the organization, resulting in a low quality of risk management performance.

However, the question arises how representative the qualitative data is, it should be examined to what extent these bottlenecks influence the quality of performance. For example, it could be easier to blame people in lower levels in the hierarchical structure than higher levels. It is easier to blame a colleague instead of the boss. If the qualitative data is representative, the examined data seems to appoint the problems in the lower layers in which risk management is performed.

Based on result 2 and 3 the following discussion is relevant: adding or clarification. Additional research should be conducted to define if adding or clarifying is necessary. However, from the differences in levels it seems that an unbalanced situation occurs. At Heijmans, risk management seem to be mainly performed at a top level in which mainly attention is paid to the design of the process. Currently, the organization is still developing new processes for risk management. The results from practice shows the following elements as main bottleneck: risk management is an additional tool, the project team is occupied with their own complex core tasks, there is less ownership, unclear processes and risk management is a burden. These results are highly related to the project team area, the lower levels in the organization. Several bottlenecks are recognized in the quality of performing of risk management. Therefore, it is likely that gathering information from these lower levels on how risk management should be improved, will improve the whole process. This assumes that the gathered qualitative data in this study can be interpreted as a reflection of real-life. However, an additional validation or research should be conducted to verify if the combination of these approaches provides an improvement in the risk management process in practice.
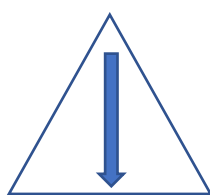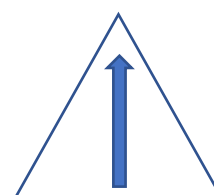

Figure 8.2. Current situation   *Figure 8.3. Recommended addition*

Third, the difference between result 1 and 3: adding process steps and the factors that influence the quality of risk management performance. If the context, risk response plan and statements are added, it should be asked to what extent the addition will influence the quality of performance in risk management. It could be of additional value, in contrast, implementing more elements can lead to a more complex, unclear process, unfamiliarity or takes additional time. In addition, the level of communicating and documenting is less than other aspects. These two elements will become more difficult to perform when more elements will be added. These are bottlenecks for performing risk management in practice. The main question on adding or neglecting the context, risk response plan and statements is: What effect does adding the statements have on the quality of performing the risk management process? It is hard to examine this effect.

To improve risk management in large infrastructure projects, it is likely that considering theory and practice is beneficial. By comparing the parts, mainly results on how to improve the practice based on process steps from theory is considered. Since a small amount of differences occurred between those parts, the current risk maturity level of risk management in practice will be extensively discussed based on best-practices. The results of the case study present a clear need for improvement in a larger extent than only implementing the process steps perfectly. Therefore, the statements defined based on best-practices should be included in the discussion. By conducting a case study in which respondents of the top management team and project members are considered, a clear overview of experiences related to risk management in practice is gathered of these two levels within the project.

High deltas resulted in the outcomes of the model, which means that it is hard to define the outcomes as reliable. Since 'Policy & Strategy' and 'Culture & Personnel knowledge' have a small delta, those outcomes are most reliable. 'Policy & Strategy' is defined as the most mature aspect within the projects, and 'Culture & Personnel knowledge' as less mature aspect. 'Policy & Strategy' is highly related to the designed process and are well implemented. 'Culture & Personnel knowledge' is related to the organizational aspect of risk management but influences the performance of risk management to a large extent. Based on these findings, it seems that a twofold occurs in designed processes and performance of the processes. To validate this, more aspects are considered which are process-based or performance-based. In addition to 'Policy & Strategy', 'Risk Assessment' is a mature aspect, also related to the processes and the system. The less mature aspects besides 'Culture & Personnel knowledge' are: 'Top management commitment', and 'Monitor & Review', and the component 'Communication' which are related to the performance of risk management. From this data, is seems that setting up processes and a systematical risk approach is beneficial. Additionally, an insufficient level of risk management performance occurs: the quality. This discussion seems to be in line with the second discussion. This results in a validation that the need seems to be there from several perspectives, however, as mentioned in all discussion, additional research is necessary to find the root-causes to validate these results.

A side discussion that arises and is important to consider in additional research is, 'What if the group of interviewees was bigger and more project members at lower levels were interviewed?'. For example, within the project, less ownership is mentioned as bottleneck. But, is it really related to ownership or is it a result of another bottleneck? Moreover, some statements and qualitative explanations were related to another person than interviewed. If person A says something about person B but person B never validates this, can it be assumed as true? The number of interviewees and the different levels of activity of the interviewees play an important role in generating the results. Therefore, it would be helpful if these numbers and different roles of respondents would be expanded and this should be considered for further research.

8.3. Implications

This section explains the implications of the study in practice and in theory. The aim of this research is to contribute to the practical and scientific side of risk management.

8.3.1. Practical contribution

The method which is used in this thesis to indicate the current situation of the risk maturity in practice can be of additional value for Heijmans. As mentioned, the advantage of the 'één ontwikkelproces' project is the implementation of gate reviews for the design, construct, and asset disciplines. A less extended version of the used model could be included in these gate reviews. Besides, the difference between theory and practice is essential to include. The model consists of 51 statements that determine the risk maturity in the organization. While considering these statements, a useful review document can be designed. In this way,

an improvement can be made in the infrastructure projects since it is made more SMART, controllable, and based on theory.

Moreover, it should be examined whether RISMAN is a sufficient standard within the contractor's organization. Within this thesis, a clear overview is given about elements that should be included in risk management processes. As the comparison between Part A and B show differences, it could be useful to search for standards or guidelines that include those elements that lack in the guideline of Heijmans. At present, the implementation of RISMAN is mostly copy pasted into projects. It focuses on control measures, however, in practice those control measure steps where not sufficiently performed. Maybe, another standard that is examined in this research could contribute to a contractor's organization.

8.3.2. Scientific contribution

This thesis elaborates on four studies. These four studies show similarities but also contrast. The contrast that was obvious within this study is the difference in, on the one hand, adding context, risk response plan and statements to the risk management standard and, on the other hand, a process that encourages the quality of performing risk management. Encouraging the quality of performing risk management results from the qualitative research in which, for example, the unclear process, unclear document overview, burden, and risk management is time-consuming are formulated. Two levels within a project are identified based on these findings. The top management level that pays a lot of attention to the design of processes and systems and the action holders in the lower levels that perform risk management. The involved people in risk management determine the performance of risk management as hard in which the quality is not guaranteed. It seems that more attention is paid on how risk management should be performed based on theory. This is substantiated with the extensive literature studies based on risk management standards, it seems that it had the focus of scientists. Less literature can be found about how risk management should be performed in practice and the bottlenecks that are identified in practice. This thesis pinpoints the bottlenecks within the performance of risks management. An optimal balance to answer the research question of this thesis should be examined in further research.

8.4. Limitations

This study includes several limitations that should be highlighted. The limitations are based on the findings and the used model.

8.4.1. Limitations of the findings

Three limitations occurred within the findings of this research. Two limitations are related to the quantitative data. The other limitation is related to the current developments within the contractor's organization.

Difference in interpretation

This limitation is twofold. First, several interviewees substantiated statements with similar answer, but ranked it differently. An example: both interviewees mention that it is not conducted explicit. However, the risk manager states it with a 3 and the design manager with a 7. Second, respondents did not recognize a certain statement and ranked it as sufficient. A real-life example, a design manager has defined the first statement with a 7 but says: 'I have not noticed that we have communicated a strategy several times, maybe at the beginning'. He has not noticed it, but ranks it with a 7. These differences in interpretation have a high impact on the quantitative results since only two respondents per project were included. Therefore, it is recommended to include more respondents per project to gain solid data.

The scores of Project Y depend on a single respondent

Since the design manager of project Y filled in several statements with a question mark, a skew result appeared from the model. Since the model recognizes the question mark as 0. Therefore, it is representable if the results of Project Y only include the data of the risk manager to consider for further examination. However, it would be preferable if a solution can be found for filling in question marks within the model. A limitation can be the printed version of the statements, in which it is possible to fill in question marks. If the scores were filled in in the online model, it was not possible to consider question marks and a choice has to be made between 0, 3, 7 or 10. Therefore, first, the recommendation is to include question marks within the model and second, more respondents should be included in further research to reduce the impact of this problem.

Improvements within Heijmans regarding risk management

At present, 2017, a lot of attention is paid to risk management within the organization. A CRO is appointed and the risk management team is almost doubled. Most of the analyzed projects started before 2017. In these projects, the new project management plan is implemented, and some of the risk management improvements are included. However, several identified problems in this thesis were already recognized by the organization and included in the new strategies. The limitation of this research is the period in which it is conducted. The research materials are based on an old risk management strategy and a new project management strategy. Moreover, some bottlenecks are already recognized by the organization and for some, fulfillment is/will be given. For example, the lessons learned and ownership.

8.4.2. Limitations of the model

Two limitations for the model are recognized while conducting the interviews.

There are no specific statements for the design phase

After sharing ideas, it became clear that the risk appetite is highly executed in the tender phase of the infrastructure projects. It is not of additional value if a lot of attention is paid to this in the design phase as it is mentioned as a good and well-organized process in the tender phase. The design manager ranked all of these statements with 7 or 10. Of which eight statements are ranked with 10 and five statements are ranked with 7.

Question marks

The limitations at this point are that the design manager of Project Y did not recognize the statements of the 'Risk Treatment' and 'Monitor & Review'. He was not fully aware of the level of implementation of the statements. Therefore, his scores will not be considered for further analysis. The results of the risk manager of Project Y will be used as average for the project. This could lead to a skewed conclusion in the end while comparing the averages of the design manager and risk manager with only the risk manager of Project Y. From the author´s perspective, the 'Risk Treatment' is the first aspect that needs improvement.

9. Conclusion and recommendations

The conclusion has the aim to answer the main question based on the sub-questions. These are elaborated in section 9.1. Finally, recommendations for Heijmans, further research and the model are formulated.

9.1. Tentative conclusion

Given the problem statement, there is a need to improve the integration of risk management in the 'één ontwikkelproces' projects at Heijmans. These projects were created to reduce the risks up front. The 'één ontwikkelproces' strategy is a newly implemented project management strategy in which design, construction and maintenance is designed in parallel. In this way, risks should be managed up front. But how can the risk management process be improved in such a way that the risks are controlled in a more preventive way in large infrastructure projects?

1. *What are the important steps in a risk management process?*

To gain knowledge about these risk management standards, thirteen risk management standards are examined. A selection of these standards is made to define which standards are relevant for this study. This selection resulted in the following eight risk management standards: PMBOK, RISMAN, IEC 62198:2013, BS6079-3:2000, CAN/CSA-Q850-97, FERMA AND IRM, PRAM AND ATOM. Further research on these standards is performed to generate an Evaluation Framework. This Evaluation Framework contains the critical elements that must be included in risk management standards to integrate risk management in project management. After intensive research based on the terminology, level of detail, planning, risk identification, risk analysis, risk treatment and risk control, an Evaluation Framework is created. The four main elements that should be included in risk management are: project context, risk identification, risk assessment, and risk response. These four elements must be performed as an iterative process. The content of these four elements are presented in Figure 9.1:
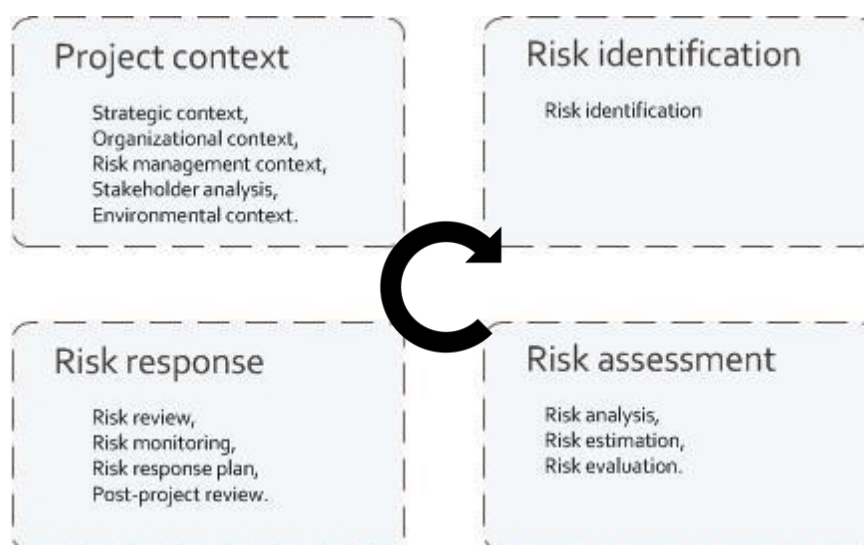

Figure 9.1. Evaluation Framework

2. What are the differences between the Heijmans guideline and the Evaluation Framework?

The main- and sub-steps are considered while comparing the Evaluation Framework with the guideline of Heijmans. This comparison leads to the conclusion that the guideline of Heijmans is highly detailed and shows a lot of same elements as the Evaluation Framework. Three of the seven main steps are related to control measures which is more than in the Evaluation Framework and is seen as an advantage. However, the comparison also shows some shortcomings in the guideline of Heijmans. Three differences that are not included in the guideline of Heijmans are identified: there is no mentioning of all elements in the context, post-project review element, and risk evaluation. First, the context is considered in the risk management plan. However, only the contract documents and the client are considered in this element. Mostly the risk management plan is a tool to confirm the risk management actions. The risk management plan is made to implement in the project management plan, this means that the risk management plan is an addition to the project management plan while it must be integrated. Second, the post-project review is not mentioned either. The post-project review is about capturing and recording the lessons learned for future projects. Third, the risk evaluation is not mentioned. Within the guideline, only risk identification and quantification is considered. After these steps, the guideline determines the control measures.

3. To what extent is risk management carried out in practice?

In general, for every project, the averages (from the quantitative analyses) are higher than 6/10, which means that the risk maturity level is mature. The tools and techniques are well implemented. The elements 'Policy & Strategy' and 'Risk Assessment' are highly mature in which the 'Risk Assessment' aspect shows the smallest delta and is therefore most reliable. These two aspects are related to the pre-defined processes and systems within the risk management process. The less mature elements in practice are the aspects 'Culture & Personnel knowledge' which is recognized in every analysis as one of the two least mature aspects. This aspect also shows a small delta and is therefore stated as reliable. The other less mature aspects differ per projects. Nonetheless, 'Monitor & Review' has the smallest average of all respondents, but shows the highest delta which means that respondents do not agree upon the same level of implementation and is therefore less reliable.

Every aspect contains several statements, based on these statements, the level of maturity is generated. The statements that were implemented to a small extent are mainly part of the 'Culture & Personnel knowledge', 'Monitor & Review', and 'Top management commitment'. However, these statements differ per project. In addition, the ambition level statements also differ per project. While combining all the statements, the amount of statements regarding communication and documentation were noticeable. Within the whole project, there are 5 statements related to communication and 4 out of 5 have a high difference between the level of implementation and ambition level.

The main findings of the qualitative data are validated by experts and shows the factors that have a negative influence on the quality of risk management performance: complexity, reactive attitude, insufficient level of documentation, insufficient level of communication, busy with own complex tasks, additional tool, unclear process, less ownership, no clear overview, less risk awareness, lack of motivation, too large and unwieldy communication chain, takes too much time, no clear document overview, burden, little achievement feeling, unfamiliarity. The factors that have the largest influence on risk management performance are: busy with own complex tasks, additional tool, unclear process, and less ownership.

How can the risk management process be improved in such a way that the risks are controlled in a more preventive way in large infrastructure projects?

Based on research into the differences between the three examined parts (1) Part A: Evaluation Framework, (2) Part B: guideline of Heijmans and (3) Part C: risk management in practice, three results are formulated. First, adding process steps, based on the differences between those parts. Second, the high-risk maturity of processes at Heijmans, based on the case study. Third, the four factors that have a large negative influence the risk management performance, based on qualitative research. Based on these results, three discussions can be formulated. First, adding steps and the high-risk maturity level. Second, a high-risk maturity level of the current process at Heijmans and four factors that influence the quality of Heijmans. Third, adding process steps and the factors that influence the quality of risk management performance.

All three results seem to be contradictory. However, adding elements can have a negative effect on the quality of risk management performance. But whether this negative effect arises should be examined in further research. Theory mainly stipulates how risk management should be designed ideally. These designed processes resulted as mature in the examination in this study. At present, Heijmans pays a lot of attention to the design of risk management processes. From the second and third discussion, it seemed that it is likely that the factors that influence the risk management performance should receive more attention. Especially, while the process already receives a lot of attention it seems that factors still influence the performance of risk management in practice. Therefore, the tentative conclusion arises that more fulfillment should be given to elements that encourage the quality of risk management performance. In this way, first improvements in the risk management process seem to be made. In further research, an examination should be conducted into the optimal balance between risk management processes and the quality of performing these processes to improve risk management. In this research, adding elements should be included and the effect of adding elements on risk management performance.

9.2. Recommendations

This section elaborates on the recommendations based on the study for Heijmans, further research, and for the used model.

9.2.1. Recommendations for Heijmans

Decide for whom the risk management document is written
Do these persons understand this document? A collaboration between the top level and lower level is preferable. What is mentioned by all interviewees is the well described risk management process. However, description is step one and performance is step two. The performance of risk management process requires improvements. For who is the process described? Is it internal or external. If no one internal understands the process, why should it be done in this way?

A process is more than following standards and guidelines
The quality of performing risk management can be extended by generating knowledge from the lower levels within a project organization. Management level and project team level must be bundled. Top down and bottom up structures must meet each other. In this way, the whole project organization is involved in project processes and ownership will lead. At management level, it is necessary to communicate with the internal and external stakeholders, communicate with the rest of the project team about the risk management approach and make sure the risk awareness is present and flows from top to down. On a project team level, it should be relevant to define what the requirements for risk management are from a lower level within the organization. To pay more attention to the performance of risk management and the

layer in which risk management is performed, processes can be made clearer and less abstract. The whole organization will become familiar with the process.

9.2.2. Recommendations for further research

Research in other companies and/or other projects
Results are based on findings of Heijmans, if it is a structural improvement for the academic sector further analysis is required in other construction firms or other branches. This is necessary to gain a solid conclusion for improving the risk management process. The sample will be larger and a more valid conclusion can be drawn.

Extend the amount of respondents
Include more interviewees to gain a larger sample that results in more valid results. In this study, only the design managers and risk managers are included. To make sure the drawn conclusion is valid, respondents of lower levels in the project organization must be included as well.

Defining the correlations and effect of the three results
Including the results of this thesis would be useful for additional research. It is of additional value to find the correlations between those three results and what the effect of improving one of the three results is on other results. In this way, better continuation could be given to the results.

9.2.3. Recommendations for the model

Specify the list of statements per field of activity per company
From the interviews, it became clear that most of the respondents had some questions about the risk appetite. This is mostly part of the tender phase, and it is recommended to add a tool to the research method in which the different phases, such as tender and design phase, can be divided.

Change the scores
For interviewees, the way of scoring is unclear. For some columns, the values are expressed in A, B, C, and D, while the value of these letters are respectively 10, 7, 3 and 0. In addition, the scores in other columns are determined by the values 0, 3, 7, and 10.

Implementing a system or guideline area besides the organizational and applicational areas
The division in the two areas 'organizational' and 'application' seems not representative. The 'Policy & Strategy', 'Top management commitment', and 'Culture & Personnel knowledge' are part of the organizational area. The 'Risk Assessment', 'Risk Treatment' and 'Monitor & Review' are part of the application and process area. However, the 'Policy & Strategy' and 'Risk Assessment' are related to the systems behind the risk management performance. This is based on the guidelines as described by the organizations. A different proposed division could be: (1) description, system, or guideline area, (2) organizational area and (3) application area.

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Appendices

Appendix A – één ontwikkelproces model

Appendix B – Background projects

Appendix C – Quantitative analysis

Appendix D – Qualitative analysis

Appendix E – Analysis steps of the standards

Appendix F – Analysis planning category

Appendix G – Analysis identification, analysis, and treatment category

Appendix H – Analysis risk control

Appendix I – Risk management guideline of Heijmans