Performance indicators in the Best Value approach

Proposed process for developing and using performance indicators for infrastructural projects approached with Best Value

Allard Horstman

MASTER THESIS

Performance indicators in the Best Value approach

Proposed process for developing and using performance indicators for infrastructural projects approached with Best Value

Rijkswaterstaat
Ministry of Infrastructure and the Environment

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COLOPHON

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PREFACE

This thesis is the end of my graduation period of the master Civil Engineering & Management at the University of Twente.

The preparation of this graduation period started almost a year ago, when I contacted Wiebe Witteveen of Rijkswaterstaat and asked him about the opportunities to graduate on Best Value Procurement. Not long before, my supervisor at the university told me about Best Value. The innovative approach took my attention and eventually, Wiebe and I chose the subject of performance indicators in Best Value. This was an under researched topic in Best Value and it had the interest of the Best Value core team at Rijkswaterstaat. Now, at the end of my seven-month research, I can say that performance indicators are of increasing importance in Rijkswaterstaat's Best Value projects. I believe that measuring is the key to successful learning and development in and over projects.

Of course, I would like to thank my organisation supervisor Wiebe for all his help during my graduation period and for giving me the opportunity to graduate at Rijkswaterstaat. From the beginning, you gave me confidence in this research and I enjoyed working with you. Good luck the coming years with your doctoral research! I would also like to thank the other members of the Best Value core team of Rijkswaterstaat. Johannes, Wouter, Jolanda, and Gül: thank you for your help, your critical but supporting comments, the numerous interesting discussions and the great working atmosphere. I thank my colleagues from the section IMG/AICL for the nice, though sometimes tough, graduation time and my university supervisors Hans Voordijk and Saad Al-Jibouri for their time to supervise this research, for their support and the fruitful discussions during my graduation.

For this graduation, I moved to Utrecht. My friends in Utrecht, Bart and Jeroen, were a great support during this time. Also other (study) friends who contributed to this research: thank you.

Of course, I would like to thank all the interviewees that contributed to this research, both from Rijkswaterstaat and market parties. Without your help, this research was not possible. Your willingness to participate in this research underlined the relevance of research on performance indicators in Best Value projects and is greatly appreciated.

After this research and my graduation, I will start as trainee at Rijkswaterstaat. During my graduation, I got fascinated of the work of Rijkswaterstaat and decided to apply for trainee. I would like to thank everyone who supported me in this process. I am looking forward to really start working at Rijkswaterstaat and to contribute to the civil engineering and landscape of the Netherlands.

Allard Horstman

Enschede, 17 September 2013

SUMMARY

The construction industry is evolving. The traditional focus on lowest price is no longer sufficient, because this leads to an adverse relation between client and contractor and to a low profitability for the contractor. Best Value is an emerging method where the focus is not on lowest price, but on the best price-value ratio. It is a procurement, project management, and risk management approach, based on the concepts of win-win, less management, direction and control, and transparency. The approach consists of three phases: selection, clarification, and execution.

The goal of the selection phase is to select the expert contractor with a high value for a low price. While traditional procurement is based on comprehensive tenders, the Best Value approach requires suppliers to deliver three two-page submittals, namely a project capability submittal, risk assessment plan, and a value-added plan. After that, interviews are held with key personnel of the suppliers, to find out whether they can manage the project and identify risks upfront. In both the submittals and the interviews, suppliers can use verifiable performance information to support their claims in a short and clear way. Moreover, they can propose performance indicators for the execution phase, in order to show how they measure the claims during the project. The selection phase ends with a prioritised list of suppliers. The submittals and interviews count for 75% and the price for only 25%.

The best-prioritised supplier proceeds to the pre-award clarification phase. In this phase, the prospective contractor pre-plans the project, aligns the expectations with the client, develops risk mitigation measures for all project risks, and develops a set of performance indicators, if not done in the selection phase. When the clarification phase is run successfully by the prospective contractor, the contract is awarded.

During the execution phase, no management, direction and control has to be used by the client, since the selected contractor is the expert. To keep the client updated, the contractor has to send a Weekly Risk Report to the client each week. The performance indicators, as determined in the clarification phase and as measured by the contractor, are communicated by means of this report. If needed, risk mitigation measures have to be developed. The indicators provide transparency about the performance on project goals, about the allocation of risks, and they are the base of learning and improvement for both client and contractor. The performance information can be used by the contractor in a next tender. From the perspective of the Information Measurement Theory, the theory behind the Best Value approach, performance indicators are a form of so-called dominant information: they are non-disputable, verifiable, and accurate. They mitigate risk by transparency and enable experts to explain complex situations in a simple way to non-experts. From the perspective of New Institutional Economics, performance indicators in Best Value projects reduce uncertainty, take bounded rationality into account, and reduce the tendency to opportunistic behaviour.

Rijkswaterstaat, the executive body of the Dutch Ministry of Infrastructure and the Environment, uses Best Value since 2010, when it was used to approach 16 road-widening projects of the Spoedaanpak programme. Because these pilot projects were a success, Rijkswaterstaat decided to implement Best Value in other projects.

Performance indicators were not used in the first projects, but contractors are now obliged to develop and use performance indicators. However, Rijkswaterstaat and the contractors find it hard to develop and use performance indicators. To find out what problems are encountered, interviews are held with project team members of both Rijkswaterstaat and contractors. The encountered problems relate to (1) the introduction of performance indicators, (2) the awareness of both client and contractor of the goals of measuring causing a lack of motivation, (3) the lack of knowledge regarding the development and use, and (4) the availability of data and benchmarks. Furthermore, a quantitative analysis showed that more than 98% of risks in earlier Best Value projects are owned by the client, while most projects interviewed mainly measure the contractor. This research focuses on the lack of knowledge regarding the development and use, because most problems related to this subject.

First, theory on performance indicators in general, but especially in the construction sector is studied. This study shows that there is a wide range of performance indicators and characteristics for indicators. An analysis on these performance indicators and characteristics led to a set of characteristics for the development and use of performance indicators that is useful in Rijkswaterstaat's Best Value projects.

Subsequently, the characteristics are put into a model. The model is developed by distributing the characteristics over six different steps. A draft version of the model is evaluated by project team members from both client and contractor of current Best Value projects. Based on the feedback of this evaluation, the model is refined and a final model is made. The steps in this final model include choosing the set of indicators, choosing indicators, development of indicators, incorporate in Weekly Risk Report, use during execution of the project, and evaluation. The model consists of 20 characteristics in total. The model is tested on two Best Value cases. In the first case, the model is used in a session with client and contractor during the clarification phase. During the session performance indicators are developed. After the session, the contractor further worked out these indicators. In the second case, the model is used as a checklist. Improvements are suggested by the client based on the model and subsequently the contractor further refined the indicators. In a set of five indicators, this led to 12 improvements that are directly related to the model.

Finally, conclusions are drawn and recommendations are made to Rijkswaterstaat. The goal of performance measurements and the benefits of using performance indicators should be explained better and more practical to both market parties and the project teams of Rijkswaterstaat. More attention has to be paid to performance indicators during the clarification phase. Ensure that the indicators are supported by the project team of client and contractor. Use the model to support a session for performance indicators and to check whether the characteristics of performance indicators are present. Ensure that action is taken when an indicator is below the threshold. Consider prescribing some generic indicators, in order to enable benchmarking. Evaluate the use and the impact of performance indicators during and at the end of a Best Value projects. Involve market parties in the use, the evolvement, and evaluation of performance indicators at Best Value projects. Further research should be done on the course of the clarification phase, the overlap with other processes at Rijkswaterstaat, and on the effect of performance indicators on Best Value project success.

SUMMARY (DUTCH)

De bouwsector verandert. De traditionele focus op laagste prijs voldoet niet langer, omdat dit leidt tot een tegengestelde verhouding tussen opdrachtgever en opdrachtnemer en tot een lage winstgevendheid voor de opdrachtnemer. Best Value, in het Nederlands ook wel prestatie-inkoop genoemd, is een opkomende methode waarbij de focus niet op laagste prijs is, maar op de beste prijs-kwaliteitsverhouding. Het is een aanbestedings-, projectmanagement- en risicomanagement-aanpak, gebaseerd op de concepten win-win, minder sturing en controle en meer transparantie. De aanpak bestaat uit drie fasen: selectie, onderbouwing en uitvoering.

Het doel van de selectiefase is om de inschrijver te selecteren die de 'expert' is en die een hoge waarde voor een lage prijs biedt. Waar traditionele aanbestedingen zijn gebaseerd op omvangrijke aanbiedingen, vraagt Best Value inschrijvers om drie plannen van elk twee pagina's: een prestatie-onderbouwing, risicodossier opdrachtgever en een kansendossier. Vervolgens worden interviews gehouden met sleutelfunctionarissen van de mogelijk toekomstige projectteams van de opdrachtnemer, om zo erachter te komen of zij het project kunnen overzien en risico's van tevoren kunnen identificeren. In zowel de plannen als de interviews kunnen inschrijvers verifieerbare prestatie-informatie gebruiken om hun claims op een korte en duidelijke wijze te onderbouwen. Bovendien kunnen zij hier al prestatie-indicatoren voorstellen welke in de uitvoering gemeten gaan worden, om zo de prestatie te meten van de gemaakte claims. De selectiefase eindigt met de beoordeling van de inschrijvers. De plannen en de interviews voor 75% meetellen en de prijs slechts voor 25%.

De best beoordeelde inschrijver gaat door naar de onderbouwingsfase, de fase voor de gunning. In deze fase plant de beoogd opdrachtnemer het gehele project, schakelt hij de verwachtingen met de opdrachtgever gelijk, maakt hij bij ieder risico een mitigerende maatregel en ontwikkelt hij een reeks prestatie-indicatoren, indien deze niet in de inschrijving vermeld waren. Als de onderbouwingsfase succesvol is afgerond door de beoogd opdrachtnemer volgt de gunning.

Tijdens de uitvoering wordt geen sturing en controle uitgeoefend door de opdrachtgever, omdat de geselecteerde opdrachtnemer wordt gezien als de expert. Om de opdrachtgever op de hoogte te houden stuurt de opdrachtnemer iedere week een Wekelijkse Rapportage naar de opdrachtgever. De prestatie-indicatoren, zoals bepaald in de onderbouwingsfase, worden gemeten door de opdrachtnemer en worden ook gecommuniceerd in deze rapportage. Indien nodig worden risico-mitigerende maatregelen getroffen. De indicatoren bieden transparantie op de prestatie op projectdoelstellingen en op de allocatie van risico's en zijn de basis voor leren en verbeteren voor zowel de opdrachtgever als opdrachtnemer. De prestatie-informatie kan door de opdrachtnemer gebruikt worden in een volgende inschrijving. Vanuit het perspectief van de Information Measurement Theory, de theorie achter de Best Value aanpak, zijn prestatie-indicatoren een vorm van zogenoemde dominante informatie: ze zijn onbetwistbaar, verifieerbaar en accuraat. Ze mitigeren risico's door het geven van transparantie en ze stellen experts in staat om complexe situaties op een simpele wijze uit te leggen aan niet-experts. Vanuit het perspectief van de Nieuwe Institutionele Economie reduceren prestatie-indicatoren in Best Value

projecten onzekerheid, houden ze rekening met begrensde rationaliteit en reduceren ze de neiging tot opportunistisch gedrag.

Rijkswaterstaat gebruikt Best Value sinds 2010, toen het werd gebruikt om 16 Spoedaanpak-projecten te benaderen. Omdat deze pilotprojecten een succes bleken heeft Rijkswaterstaat besloten Best Value ook te implementeren in andere projecten. Prestatie-indicatoren zijn niet gebruikt in de eerste projecten, maar opdrachtnemers zijn nu wel verplicht om ze te ontwikkelen en te gebruiken. Toch vinden Rijkswaterstaat en opdrachtnemers het lastig om prestatie-indicatoren te ontwikkelen en te gebruiken. Om te weten te komen tegen welke problemen zij aanlopen zijn interviews gehouden met projectteamleden van zowel Rijkswaterstaat als opdrachtnemers. De ervaren problemen hebben te maken met (1) de introductie van prestatie-indicatoren, (2) het besef van zowel opdrachtgever als opdrachtnemer van het doel van meten, waardoor er een gebrek aan motivatie ontstaat, (3) een gebrek aan kennis met betrekking tot de ontwikkeling en het gebruik van prestatie-indicatoren en (4) de beschikbaarheid van data en benchmarks. Bovendien laat een kwantitatieve analyse zien dat de opdrachtgever 98% van de risico's bezet, terwijl de meeste geïnterviewde projecten voornamelijk de opdrachtgever meten. Dit onderzoek richt zich op het gebrek aan kennis met betrekking tot de ontwikkeling en het gebruik van prestatie-indicatoren, omdat de meeste problemen hieraan gerelateerd zijn.

Eerst is theorie op het gebied van prestatie-indicatoren in het algemeen, maar vooral in de bouwsector bestudeerd. Deze studie laat zien dat er een breed scala van prestatie-indicatoren en karakteristieken voor indicatoren bestaat. Een analyse op deze prestatie-indicatoren en karakteristieken heeft geleid tot een reeks karakteristieken voor de ontwikkeling en gebruik van prestatie-indicatoren welke bruikbaar is in Best Value-projecten.

Vervolgens zijn de karakteristieken verwerkt in een model. Het model is ontwikkeld door de karakteristieken te verdelen over zes verschillende stappen. Een conceptversie van het model is geëvalueerd door projectteamleden van Best Value projecten, van zowel opdrachtgevers- als opdrachtnemerszijde. Op basis van de terugkoppeling van deze evaluatie is het model verder verfijnd en een definitief model gemaakt. De stappen in het definitieve model zijn het kiezen van de reeks indicatoren, het kiezen van de indicatoren, het ontwikkelen van de indicatoren, het opnemen in de Wekelijkse Rapportage, het gebruik tijdens de uitvoering en het evalueren. Het model bestaat in totaal uit 20 karakteristieken. Het model is getest op twee Best Value-projecten. In het eerste project is het model gebruikt in een sessie met opdrachtgever en opdrachtnemer tijdens de onderbouwingsfase. Tijdens de sessie zijn prestatie-indicatoren ontwikkeld. Na de sessie heeft de opdrachtnemer deze indicatoren verder uitgewerkt. In het tweede project is het model gebruikt als checklist. Er zijn suggesties voor verbeteren gedaan door de opdrachtgever gebaseerd op het model en vervolgens heeft de opdrachtnemer de indicatoren verder verfijnd. Op vijf indicatoren leverde dit 12 verbeteringen op die direct te zijn relateren aan het model.

Uiteindelijk zijn er conclusies getrokken en aanbevelingen gedaan aan Rijkswaterstaat. Het doel van prestatiemetingen en de baten van prestatie-indicatoren moeten beter en meer praktisch worden uitgelegd aan marktpartijen en projectteams van Rijkswaterstaat. Meer aandacht moet worden geven aan prestatie-

indicatoren tijdens de onderbouwingsfase. Zorg ervoor dat indicatoren draagvlak hebben van zowel het projectteam van de opdrachtgever als van de opdrachtnemer. Gebruik het model om een sessie te ondersteunen voor het ontwikkelen van prestatie-indicatoren en na te kijken of de karakteristieken voor prestatie-indicatoren aanwezig zijn. Zorg ervoor dat actie wordt ondernomen wanneer een indicator onder de drempelwaarde is. Overweeg het voorschrijven van enkele generieke indicatoren, om zo benchmarks te kunnen bepalen. Evalueer het gebruik en de impact van prestatie-indicatoren tijdens en na een Best Value-project. Betrek marktpartijen in het gebruik, de evolutie en evaluatie van prestatie-indicatoren in Best Value-projecten. Vervolgonderzoek moet gedaan worden op het verloop van de onderbouwingsfase, de overlap met andere processen bij Rijkswaterstaat en het effect van prestatie-indicatoren op het succes van Best Value-projecten.

TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Motivation 1
1.2 Problem analysis 2
1.3 Research objective 3
1.4 Research framework 3
1.5 Research questions 5
1.6 Research relevance 5
1.6.1 Scientific relevance 6
1.6.2 Practical relevance 6
1.7 Structure 6

2 BEST VALUE AND PERFORMANCE INDICATORS 8

2.1 Best Value approach 9
2.2 Best Value and performance indicators in practice 9
2.2.1 Selection 10
2.2.2 Clarification 11
2.2.3 Execution 12
2.2.4 Conclusion 15
2.3 Best Value and performance indicators in theory 17
2.3.1 Information Measurement Theory 17
2.3.2 New Institutional Economics 20
2.4 Conclusion 21

3 CURRENT PROBLEMS WITH PERFORMANCE INDICATORS 24

3.1 Problems with performance indicators at Rijkswaterstaat's Best Value projects 25
3.1.1 Research methodology 25
3.1.2 Results 26
3.1.3 Conclusion 28
3.2 Risks in previous projects 29
3.2.1 Research methodology 29
3.2.2 Case description 29
3.2.3 Results 30
3.2.4 Analysis 32
3.2.5 Conclusion 32
3.3 Conclusion 33

4 PERFORMANCE INDICATORS IN THE CONSTRUCTION INDUSTRY 35

4.1 Applicability in the construction industry 36
4.1.1 Performance indicators in general 36
4.1.2 Performance indicators in the construction industry 36
4.1.3 Types and examples of indicators 38
4.1.4 Impact of Best Value on these indicators 39
4.2 Problems with performance indicators 40
4.3 Characteristics from the literature 41
4.3.1 Research methodology 41

4.3.2 Results 41
4.4 Conclusion 47
5 DEVELOPMENT AND USE OF PERFORMANCE INDICATORS 49
5.1 Draft step-by-step model 50
5.2 Evaluation of the steps 51
5.2.1 Research methodology 51
5.2.2 Results 52
5.2.3 Analysis and conclusion 60
5.3 Final model 60
5.4 Tests in practice 63
5.5 Conclusion 63
6 CONCLUSION, DISCUSSION AND RECOMMENDATIONS 64
6.1 Conclusions 64
6.1.1 Answers to the research questions 64
6.1.2 Research goal 67
6.2 Discussion 68
6.3 Recommendations to Rijkswaterstaat 69
6.3.1 Recommendations to Rijkswaterstaat 69
6.3.2 Recommendations for further research 71
7 REFERENCES 72

LIST OF TABLES

Table 2-1: performance indicators already measured in the Weekly Risk Report.....14
Table 2-2: industry structure (D. T. Kashiwagi, 2013b).....18
Table 3-1: cases for problem analysis.....25
Table 3-2: risk owners of Spoedaanpak.....30
Table 3-3: results of data analysis Spoedaanpak.....31
Table 4-1: characteristics from the literature.....41
Table 4-2: characteristics divided per reference.....43
Table 4-3: applicable characteristics derived from the literature.....48
Table 5-1: draft model.....51
Table 5-2: word table, based on Yin (2009).....52
Table 5-3: evaluation step 1.....53
Table 5-4: evaluation step 2.....54
Table 5-5: evaluation step 3.....55
Table 5-6: evaluation step 4.....58
Table 5-7: evaluation step 5.....59
Table 5-8: evaluation step 6.....60

LIST OF FIGURES

Figure 1-1: research framework, based on Hevner et al. (2004; 2007) 4
Figure 1-2: structure of the report 6
Figure 2-1: structure chapter 2 8
Figure 2-2: Best Value process (based on Kashiwagi (2013a)) 10
Figure 2-3: example of an unforeseen event in the Weekly Risk Report 13
Figure 2-4: example of milestones in the Weekly Risk Report 14
Figure 2-5: example of other performance indicators and data in the Weekly Risk Report 14
Figure 2-6: example of a Director's Report 15
Figure 2-7: unfiltered information from project to managing director at Rijkswaterstaat 15
Figure 2-8: current role of performance indicators in Best Value 16
Figure 2-9: proposed role of performance indicators in Best Value 17
Figure 2-10: silos in the supply chain (D. T. Kashiwagi, 2013b) 20
Figure 3-1: structure chapter 3 24
Figure 3-2: further delimitation of this research 34
Figure 4-1: structure chapter 4 35
Figure 4-2: example of benchmark on client satisfaction (retrieved from KPI Engine (CCI, 2010)) 38
Figure 4-3: performance management process (based on Bititci et al., 1997) 45
Figure 4-4: traffic light reporting 47
Figure 5-1: structure chapter 5 50
Figure 5-2: final model 62
Figure 6-1: structure chapter 6 64
Figure 6-2: current use of performance indicators in Best Value 65
Figure 6-3: final version of the model, a more detailed version can be found in Figure 5-2 67

1 INTRODUCTION

1.1 Motivation

The last decade, clients in the construction industry sought for new ways to contract the best market party, because the old method of selecting only on lowest price caused several industry problems, such as an adverse relation between client and contractor and low profitability for the contractor. At the same time, a changing society put pressure on cutting governmental expenses and thus forced Rijkswaterstaat (the executive arm of the Dutch Ministry of Infrastructure and the Environment) to change its role in developing and managing infrastructure networks (Rijkswaterstaat, 2011a). As a leading client, Rijkswaterstaat now increasingly cooperates with market parties (Rijkswaterstaat, 2011b).

An emerging procurement and project management method to approach a project is Best Value[1]. Key aspects of Best Value are a win-win situation for both client and contractor, a high value for a low price, less management, direction and control of the client, and giving contractors the space to show their expertise (D. T. Kashiwagi, 2013a). The approach originates from the United States, but is now used in over 160 projects in the Netherlands and is becoming increasingly popular in several countries, by both public and private parties. The use of Best Value at Rijkswaterstaat started in 2008, when more than half of the Spoedaanpak programme (i.e. 16 of 30 projects concerning resolving major bottlenecks on the Dutch highway network) was approached with Best Value. Because of the success of the approach in this programme, Rijkswaterstaat decided to test the approach in other pilot projects. These pilot projects were not only highway projects, but also included engineering services, water projects, and maintenance. Meanwhile, fifteen projects are finished, ten projects are in progress, and seven projects are in preparation (July 2013), which means Rijkswaterstaat is one of the worldwide leaders in using Best Value. At Rijkswaterstaat, the approach is no longer a pilot, but will now be further implemented in Rijkswaterstaat's primary processes (Rijkswaterstaat Staf DG, 2013).

Over the years, the Best Value approach has evolved from only a procurement method towards a combination of procurement method, project management method, and risk management method. While the focus was first on the selection, by means of tenders with two-page submittals and holding interviews with the supplier's key personnel, nowadays the focus is more on the phases after the selection, i.e. the so-called clarification phase and the execution of the project.

An aspect that is gaining increasing attention is the use of simplistic performance measurements in all phases of a project. With these measurements, the performance can be indicated by using a performance indicator. A performance indicator not only shows the measure, but also defines a baseline in order to indicate the performance, instead of only measuring it. During the selection, performance measurements

[1] The Best Value approach is formerly known as BVP (Best Value Procurement) or PiPS (Performance information Procurement System) / PIRMS (Performance Information Risk Management System)

support the claims in a tender in a simple and non-disputable way and show the effectiveness of risk mitigations and value-added plans. During the clarification phase, and sometimes already in the selection phase, performance indicators are developed. During execution, they create transparency during execution by giving clear insight into the performance of client and contractor. Moreover, they stimulate continuous learning and improvement.

This research elaborates on the development and the use of performance indicators in the clarification and execution phase of Best Value projects. The problem is analysed and a step-by-step model is proposed for the development and use of performance indicators in Best Value projects, seen from both the perspective of client and contractor.

Research organisation

Rijkswaterstaat is the executive body of the Dutch Ministry of Infrastructure and the Environment. On behalf of the Minister and State Secretary, Rijkswaterstaat is responsible for the design, construction, management and maintenance of the main infrastructure facilities in the Netherlands (Rijkswaterstaat, 2011b).

This research is conducted at the Rijkswaterstaat Major Projects and Maintenance (Dutch: Grote Projecten en Onderhoud, GPO), which is one of Rijkswaterstaat's seven central departments. GPO ensures that the networks are and will be available. They do that by executing large construction and maintenance projects. Since the research focuses on Best Value, the research is done at the Best Value core team of the section Advice Procurement, Contract Management, and Lead Auditing.

1.2 Problem analysis

The Best Value approach is based on the research of Dean Kashiwagi. His research group developed Best Value since the 1990s. Since 2008, Rijkswaterstaat uses Best Value, based on the philosophy of Kashiwagi. Several changes are made to comply with Dutch and European legislation, but the approach is kept as close to the original as possible (Rijt, van de, Witteveen, Vis, & Santema, 2011).

As stated earlier, Best Value is evolving due to new insights based on research and the growing number of pilot projects. Nowadays, increasing attention is given to the second and third phase, i.e. the clarification and execution phase, and the role of performance information in the process. As one of the organisations that use Best Value the most, Rijkswaterstaat is interested in following these developments. Therefore, they want to pay more attention to the clarification and execution phase and improve the use of performance indicators in their projects to increase transparency, communicate in an effective way, and learn and improve.

The latest manual of the Best Value approach is the 2013 Best Value Standard (D. T. Kashiwagi, 2013a). This standard is a practical manual for implementing and using Best Value. The standard stresses the importance of the clarification and execution

phase and the need of performance indicators, but is less clear on how performance indicators should be embedded in these phases. Moreover, because Rijkswaterstaat is in an advanced stage of implementing Best Value compared to other parties, little case studies using performance indicators in Best Value projects exist.

Since 2012, Rijkswaterstaat obliges their contractors to develop performance indicators in the clarification and to use them during the execution of the project. In a Best Value project, the contractor is concerned to be the expert in its field and hence knows best what to measure. Therefore, the contractor is given freedom in how he develops and uses these indicators.

However, experiences from the first projects using performance indicators showed that it was hard to develop indicators and that the indicators were hardly used during execution. Performance measuring and communicating was a novelty for the contractors and so they encountered a lack of knowledge regarding the development and use of performance indicators. Rijkswaterstaat wants to reduce the lack of knowledge at the contractors side because in the end they also benefit from transparency, less and clearer communication, and learning and development of contractors. Moreover, they also want to know how they can improve their role in developing and using indicators.

1.3 Research objective

Concluding from the motivation and problem analysis in respectively section 1.1 and 1.2, both client and contractor require help with developing and using performance indicators in Best Value projects. Therefore, a step-by-step model will be developed to design and use indicators, which leads to the following research objective:

The objective of this research is to propose a step-by-step model for contractors and Rijkswaterstaat, for the process of developing and using performance indicators in Best Value projects.

This is realised by giving insight in the current problems regarding performance indicators in Best Value projects, by finding characteristics of how to develop and use performance indicators in Best Value projects and by testing these characteristics at current Best Value projects.

1.4 Research framework

Considering the developing character of this research, the framework chosen for this research is based on the design science framework of Hevner, March & Park (2004; 2007). Figure 1-1 shows the model as adapted for this research; the original model can be found in Appendix II.

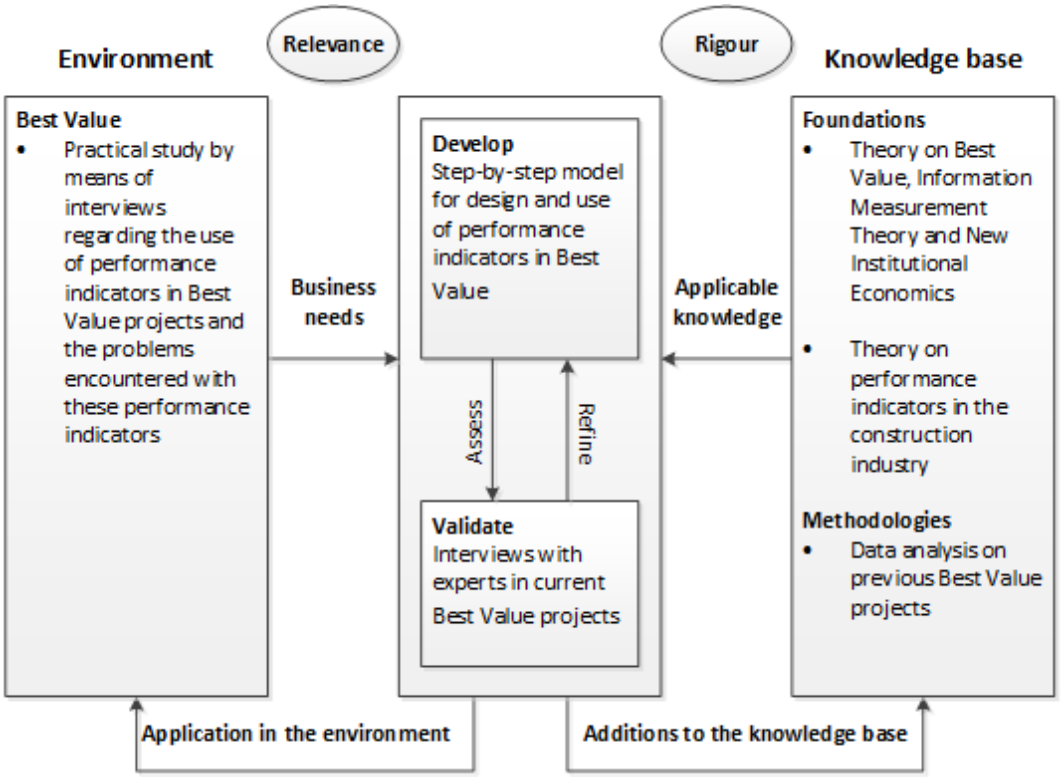

Figure 1-1: research framework, based on Hevner et al. (2004; 2007)

The primary components of forming a model are the *environment* and the *knowledge base*, which are therefore studied first.

The left side of the model shows the *environment*. In this research, this environment consists of the Best Value projects of Rijkswaterstaat and it is researched by means of interviews in current projects. The description of the environment will lead to a *business need*. This business need can be seen as the *relevance* for this research. The business need is one part of the input for the step-by-step model.

The right side of the framework shows the *knowledge base*, which consists firstly of an extensive literature study on Best Value and on performance indicators in construction and secondly of a data analysis of previous Best Value projects at Rijkswaterstaat. The literature studies and data analysis are called respectively *foundations* and *methodologies* by Hevner. The foundations and methodologies together are called the *applicable knowledge*. The quality of this applicable knowledge is called the degree of *rigour* of this research. The applicable knowledge is the other part of the input for the step-by-step model.

Next, the step-by-step model can be *developed* using the input of the business need and the applicable knowledge. A step-by-step guide for both client and contractor is chosen as kind of model. The step-by-step model is *validated* by testing the step-by-step model in practice, which is achieved by holding interviews with experts from both the client side and the contractor side. Based on this validation, the step-by-step model is refined towards the final model.

This refined step-by-step model is the output of this research. It can then be *applied in the environment* (by testing it in Best Value projects at Rijkswaterstaat) and can be *added to the knowledge base* (by describing the scientific implications). The application in the environment is done by doing recommendations to Rijkswaterstaat and presenting the step-by-step model. The additions to the knowledge base are done by writing a paper.

1.5 Research questions

Using the research framework from section 1.4, the research objective is translated into research questions, which are shown below here.

Knowledge base

Research question 1

What is the Best Value approach?

Research question 2

What is the role of performance indicators in Best Value projects?

Environment

Research question 3

What problems regarding performance indicators can be identified in current Rijkswaterstaat Best Value projects?

Knowledge base

Research question 4

How are performance indicators generally used in the construction industry?

Development

Research question 5

What model can be made regarding the process of developing and using performance indicators in Best Value projects?

Evaluation

Research question 6

Is this model applicable, relevant and effective on Rijkswaterstaat's Best Value projects?

Application and additions

Research question 7

What recommendations can be made to Rijkswaterstaat and what suggestions can be done for further research?

1.6 Research relevance

This section highlights the relevance of this research. The relevance is divided into the scientific relevance and the practical relevance.

1.6.1 Scientific relevance

The Best Value theory focuses mainly on the selection phase, seen the content of the 2013 Best Value Standard (D. T. Kashiwagi, 2013a). The steps that have to be taken in the clarification phase and during the execution are also described, but the use of performance indicators is under researched. A lot about performance indicators in construction can be found in literature, but the impact of the emerging approach of Best Value on performance indicators is not yet known and needs further research (D. T. Kashiwagi, Kashiwagi, Kashiwagi, & Sullivan, 2012). This research therefore highlights the development and use of performance indicators at Best Value projects.

1.6.2 Practical relevance

The coming years, Rijkswaterstaat intends to implement Best Value further in their primary processes. More projects will be approached with Best Value and thus more projects will be using performance indicators. Therefore, taking away the lack of knowledge concerning the development and use of these indicators is of increasing importance. It is expected that this should lead to increased professionalism of the supply chain, such as better learning and improvement and more objective discussions supported by measurements.

Because Rijkswaterstaat is one of the worldwide leading parties in the use of Best Value (Rijt, van de & Santema, 2013) and because performance indicators in Best Value are still relatively underdeveloped, many other parties are interested in how performance indicators are used in Rijkswaterstaat's projects. Therefore, the practical relevance of this research is not limited to Rijkswaterstaat and their contractors.

1.7 Structure

Figure 1-2 shows the structure of this report.

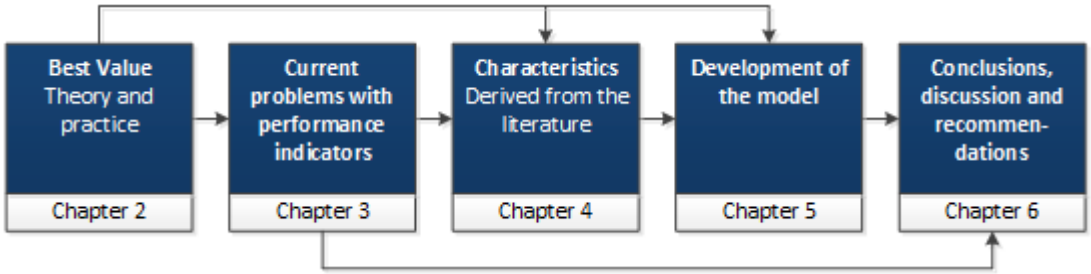

Figure 1-2: structure of the report

First, the Best Value approach, as well as the use of performance indicators in Best Value (chapter 2), are elaborated on mostly theoretically. Chapter 3 is more practical and describes the current problems with performance indicators in Best Value projects, based on interviews and data analysis.

After the problems have been identified, the focus of chapter 4 is on the theory of performance indicators and on finding solutions for the problems regarding performance indicators. In this chapter, applicable characteristics for Best Value projects will be derived, therefore, the output of chapter 2 is also used in this chapter.

Chapter 5 describes the development of the model. This development is based on the Best Value theory of chapter 2 and the characteristics found in chapter 4. A draft model is made, which is evaluated by project team members of current Best Value projects. After that, the final model for developing and using performance indicators in Best Value is made. At the end of the fifth chapter, the model is tested in two cases.

Finally, chapter 6 describes the conclusions, discussion, and recommendations. The conclusions are drawn from the model in chapter 5, but also from the problems that are found in chapter 3.

2 BEST VALUE AND PERFORMANCE INDICATORS

This chapter describes the Best Value approach from both a practical and theoretical perspective, and describes the role of performance indicators in the approach. The chapter starts with a general introduction of Best Value (section 2.1). After that, the practical part highlights the different phases of Best Value and the way performance indicators are used in each phase (section 2.2). The theoretical section (2.3) shows, from the viewpoint of two theories, the need for performance indicators in Best Value. The first two research questions are answered in the concluding section 4.4. An overview of the structure of this chapter can be found in Figure 2-1.

Research question 1

What is the Best Value approach?

Research question 2

What is the role of performance indicators in Best Value projects?

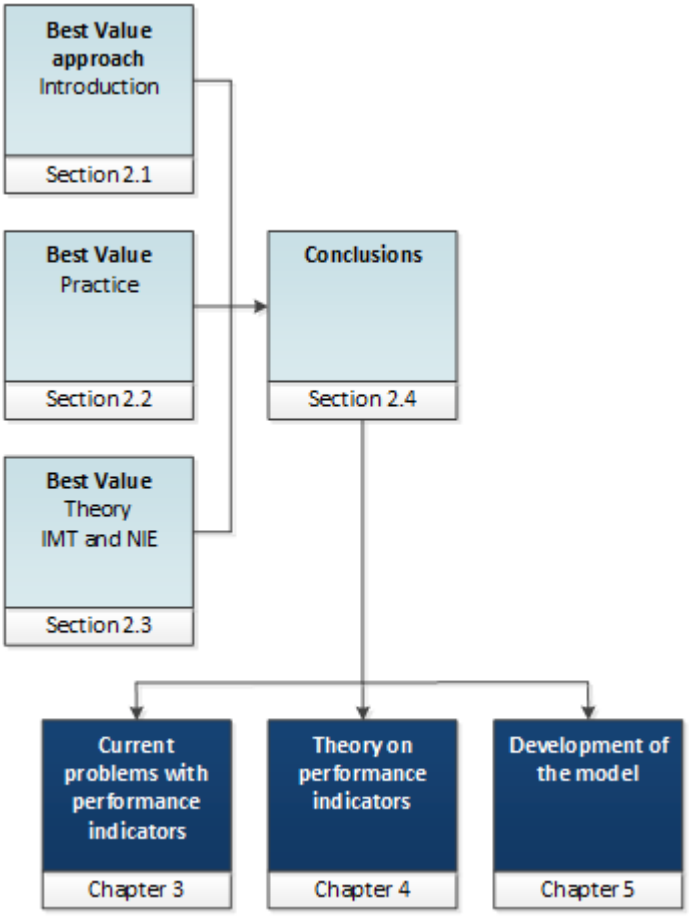

Figure 2-1: structure chapter 2

2.1 Best Value approach

Best Value is a procurement, project management, and risk management approach aimed on getting the highest value for the lowest price, with high customer satisfaction and high efficiency. The approach was developed in the 1990s in the United States by Dean Kashiwagi. By 2013, the research group that developed the approach monitored over 1,600 tests with Best Value with an amount of $ 5.6 billion (D. T. Kashiwagi, 2012; Rijt, van de & Santema, 2013), not only in the construction sector but also several non-construction sectors, for instance in IT, food services and health services (D. T. Kashiwagi, 2013a). Nowadays, Best Value is used in several countries all over the world and from these countries, *"The Netherlands has become the leader of the Best Value, (…) where the concepts are the most widely used"* (Rijt, van de & Santema, 2013, p. 10). More about the history of Best Value can be found in Appendix III.

Best Value is based on the concepts of win-win, less management, direction and control, and transparency, which is explained in section 2.3. This is achieved by using several filters in the selection phase to select an expert supplier, by running a pre-award clarification phase with this selected, so-called prospective contractor, and by project and risk management using Weekly Risk Reports during the execution of the project. A more detailed description of this process can be found in section 2.2.

The descriptions of the Information Measurement Theory and Best Value in this chapter are derived from the latest literature of Dean Kashiwagi: the 2013 Best Value Standard (D. T. Kashiwagi, 2013a) and the 2013 Information Measurement Theory (D. T. Kashiwagi, 2013b).

2.2 Best Value and performance indicators in practice

This section explains the different phases of the approach, in the way it is used at Rijkswaterstaat. The use of Rijkswaterstaat is comparable to the original philosophy; however, since Rijkswaterstaat is a public organisation and thus bound to Dutch and European procurement legislation, some adaptations have been done to fit the approach into Dutch law and European directions (Rijt, van de et al., 2011).

The approach consists of three phases, i.e. selection, clarification, and execution. Before these three phases is the contract preparation of the client. The first two phases (i.e. selection and clarification) in Best Value are pre-award; the third phase (i.e. execution) is post-award. An overview of the process can be found in Figure 2-2[2].

[2] MEAT or EMVI (Dutch) means Most Economically Advantageous Tender or Economisch Meest Voordelige Inschrijving (Dutch): an method to compare qualitative criteria and price

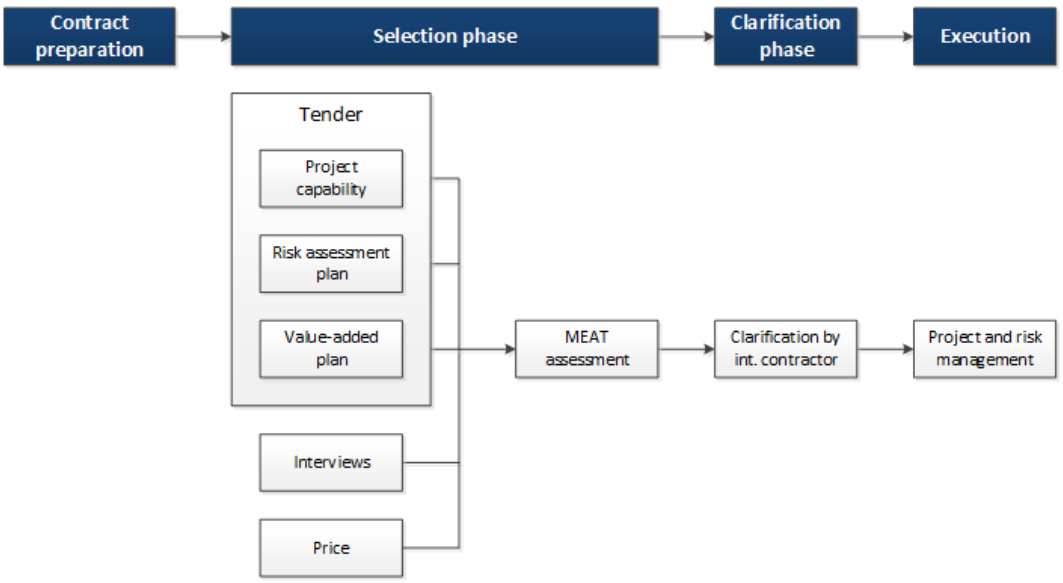

Figure 2-2: Best Value process (based on Kashiwagi (2013a))

In the next sections, respectively the selection, clarification and execution phase are described, including the role of performance indicators in these phases.

2.2.1 Selection

The selection phase consists of five filters: a project capability submittal, risk assessment plan, value-added plan, interviews, and the price. These filters are used to identify the expert supplier. In the original process, past performance is also used as a filter for selection, but due to European legislation, this is not possible at Rijkswaterstaat: it can only be used as a prequalification criterion. The submittals in the selection have to be short and dominant; therefore, the maximum number of pages per submittal (project capability, risk assessment plan and value-added plan) is two.

Project capability

In the project capability submittal, the supplier describes why he is capable to do the project.

Risk assessment plan

The risk assessment plan describes the risks concerning the client that the supplier sees upfront and the way he will mitigate them.

Value-added plan

The value-added plan enables the supplier to propose value-added options for the project. These value-added options are no part of the tender specification of the client and are not included in the tender price. After the selection, the client may decide to take the options.

Interviews

During the selection, formal interviews are held with key personnel of the supplier. These interviews are held to find out to what extent the prospective project team members can oversee the project.

Price

The price is the supplier's price for the project, without the price for value-added options. Before the tender, the client determines a maximum price for the project. The supplier's price may not exceed this maximum price.

Performance information

All the submittals and the interviews have to be supported with verifiable performance information. This enables suppliers to show their expertise in a short and clear way. Quantitative information reduces the need for subjective decisions of the client's selection committee.

Examples of verifiable performance information that can be used include the number and size of projects done by the prospective project manager, a customer satisfaction score, and the average time and cost deviations in previous projects. For instance, a supplier can show his expertise in a clear and transparent way by stating that the project manager has experience with three projects with a similar size and complexity in the same sector, which had an average customer satisfaction score of 8.6, a time deviation of less than 2%, and a cost deviation of less than 1%. This is much more transparent and objective than stating that the project manager has much experience with project of similar size and complexity, that customer satisfaction is very important to him, and that he does everything he can to avoid time and cost deviations.

In the submittals, suppliers can suggest performance indicators that can be measured during the execution, in order to support the claims made in the submittals. These indicators are then part of the tender and they can be further refined in the clarification. However, suggesting performance indicators in the submittals is not mandatory and is only used in a few cases. Moreover, Kashiwagi (2013a) does not mention the suggestion of performance indicators in the selection phase: he only states a list of performance indicators should be developed at the end of the clarification phase.

Prioritisation

All this information, together with the price, are scored by the client and subsequently prioritised. Rijkswaterstaat uses the EMVI method (Economisch Meest Voordelige Inschrijving; Most Economically Advantageous Tender) for the prioritisation, whereby the scores of the project capability (10%), risk assessment plan (20%), value-added plan (15%), interviews (30%), and price (25%) are expressed in monetary terms. After the prioritisation, the number one supplier is called the prospective contractor and he proceeds to the clarification phase.

2.2.2 Clarification

During the clarification phase, the prospective contractor is given time to pre-plan the whole project. While in the selection phase the focus was on short and dominant

plans, the prospective contractor now provides more details about his plan. Moreover, the client verifies the performance information delivered by the contractor during the selection phase.

During the clarification, the prospective contractor clarifies his scope (what is in and what is out). In addition, he draws a list of all the risks that both he and the client see upfront, together with mitigation measures for these risks. Furthermore, the client develops performance indicators that he will use during the execution of the project, if they are not suggested in the selection phase. How these performance indicators have to be developed is not described in the theory.

The clarification phase is the phase where the client can express his concerns regarding the project. It is up to the contractor to show the client that he really is the expert. The prospective contractor can use performance information to substantiate his capability. In addition, the expectations of the client and contractor are aligned. Performance indicators can be linked to this alignment, to increase transparency about the client and contractor's performance expectations during the execution. Moreover, when a risk occurs, the contractor can use the measurements to show what the performance of his mitigation measures was on that risk. In this way, the risk allocation is clear: the contractor can show whether he is accountable for the occurrence of the risk.

The clarification phase ends with an award meeting, where the client decides to award the project to the prospective contractor.

2.2.3 Execution

During the execution of the project, the focus is on project and risk management. Using the risk management plan set up during the selection and the clarification phase, the contractor tries to minimise all the risks that he cannot control.

The contractor communicates the status of the project, including progress and deviations of milestones, deviations from the schedule in time and costs, documentation of risks, and a list of performance indicators by sending a so-called Weekly Risk Report each week.

Risks and scope changes in the Weekly Risk Report

The contractor mentions three types of risks or scope changes in the Weekly Risk Report:

1. Risks from the risk management plan that are likely to occur and that have an impact on time or cost
2. Unforeseen risks that are not taken into account prior to the project and that have an impact on time or cost
3. Changes to the project scope commissioned by the client

For each of these risk and changes (in the Weekly Risk Report called "unforeseen events"), the contractor has to mention the background of the risk or change, the mitigation measure, the responsible people of the client and contractor, the estimated impact on time and cost, and a week-by-week update of the risk or change. Each week, the contract manager on the client side scores the client's satisfaction of the

contractor's risk mitigation measures. When an unforeseen has happened and it is closed, the real impact on time and cost is described. An example of a risk in the Weekly Risk Report is shown in Figure 2-3.

Unforeseen events											
No.	Date entered	Description unforeseen event	No. in risk management plan	Plan to minimize risk	Planned resolution date	Actual date resolved	Impact days to critical path	Impact to cost	Client / contractor / unforeseen	Category	Satisfaction rating
1	20-06-13	Cables and pipes are not diverted in time	38	Background - Why is this an unexpected event? Who/what is the reason? Which mitigation measures (corrective and/or preventive) will be taken? Who is responsible for which mitigation measure? What is the effect of the unexpected event (short substantiation of impact on critical path and/or cost)? Per week - updates of the unforeseen event	25-07-13		5	€ 200.000	Client	Cables and pipes	10

Figure 2-3: example of an unforeseen event in the Weekly Risk Report

Tracking the risks and changes to the project scope makes clear how the project is performing and provides details about who is accountable for the occurrence of risks. Creating this transparency in the Weekly Risk Report enables the contractor to steer on risks upfront. All Best Value projects at Rijkswaterstaat use the Weekly Risk Report.

Performance indicators in the Weekly Risk Report

Each week, the contractor communicates the performance indicators that are developed in the tender or during the clarification phase in the Weekly Risk Report. During the whole execution of the project, the contractor measures the performance of risk mitigation and thus tracks the deviations to performance or quality expectations for the project (D. T. Kashiwagi, 2013a). In addition, he can measure his own performance. The performance indicators can be used to explicitly indicate and improve the processes. The concrete implementation and communication of these performance indicators is the responsibility of the contractor, because this forces him (i.e. the expert) to communicate to the client (i.e. non-expert) in a simple and clear way. Moreover, the contractor (i.e. the expert) knows the best what to measure (after all, it is his plan that is executed) and based on his expertise, he knows what action has to be taken when the indicator is below the threshold. Unlike for the unforeseen events, a format for communicating the performance indicators does not exist.

Besides the performance indicators that are developed during the clarification phase, the Weekly Risk Report in itself also contains performance indicators, based on the unforeseen events. This is shown in Table 2-1.

Table 2-1: performance indicators already measured in the Weekly Risk Report

Performance indicator	Description
Progress on milestones	The absolute and relative progress on the milestones, filled in by the contractor
Deviation in time (estimate and real)	The total estimated and real time deviation of the project, calculated based on the impact indicated in the unforeseen events, filled in by in the contractor
Deviation in costs (estimate and real)	The total estimated and real cost deviation of the project for the client, calculated based on the impact indicated in the unforeseen events, filled in by in the contractor
Client satisfaction risk mitigation	The client satisfaction for each risk mitigation measure of the contractor, filled in each week by the client

The communication of these indicators, together with other data about the project, in the Weekly Risk Report is shown in Figure 2-4 and Figure 2-5.

Milestones

No.	Milestone	% completed	Real / estimated date of completion	Baseline date
1	Permits acquired	100%	1-7-2013	1-4-2013
2	Project finished	10%	1-7-2016	1-1-2016

Figure 2-4: example of milestones in the Weekly Risk Report

Report

Average satisfaction score	8,1

Budget

Initial/contract price	16.000.000
Initial/contract price including accepted change orders	16.500.000
Actual/planned price	17.300.000

Planning

Initial/contract date	1-1-2016
Initial/contract date including accepted change orders	1-7-2016
Actual/planned date	1-7-2016

Figure 2-5: example of other performance indicators and data in the Weekly Risk Report

Director's Report

Each week, the deviations in time and costs, the client's scores on the risk mitigation measures and a calculated risk score are summarised into a few Director's Reports. This information comes directly from the Weekly Risk Reports. In this way, the information from the contractor and the scores of the client are put without the interference of project manager or others into the DR and therefore the director gets unfiltered, transparent information from the project. At this moment, performance indicators are no part of the Director's Report. An example of a Director's Report is shown in Figure 2-6.

Director's Report week 29 (12 July 2013 - 18 July 2013)										
Sector	Project name	Contractor	Initial/contract price including accepted change orders (€)	Deviation	Deviation	Initial/contract date including accepted change orders	Actual/planned date	Planning exceeding	Client satisfaction score	Risk score
Wet	Project 1	Contractor 1	18.600.000	2.600.000	14%	1-2-2015	1-5-2015	12%	10	0,5
Wet	Project 2	Contractor 2	65.000.000	12.300.000	19%	1-9-2016	1-3-2018	34%	4	3,2
Dry	Project 3	Contractor 3	16.500.000	500.000	3%	1-1-2018	1-1-2018	0%	8	0,1

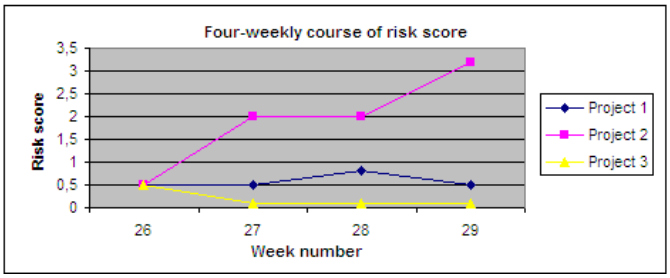

Figure 2-6: example of a Director's Report

At Rijkswaterstaat, the Director's Reports are directly communicated to the managing directors. The process of Weekly Risk Reports (WRs) and Director's Report (DRs) in Rijkswaterstaat's organisation is shown in Figure 2-7.

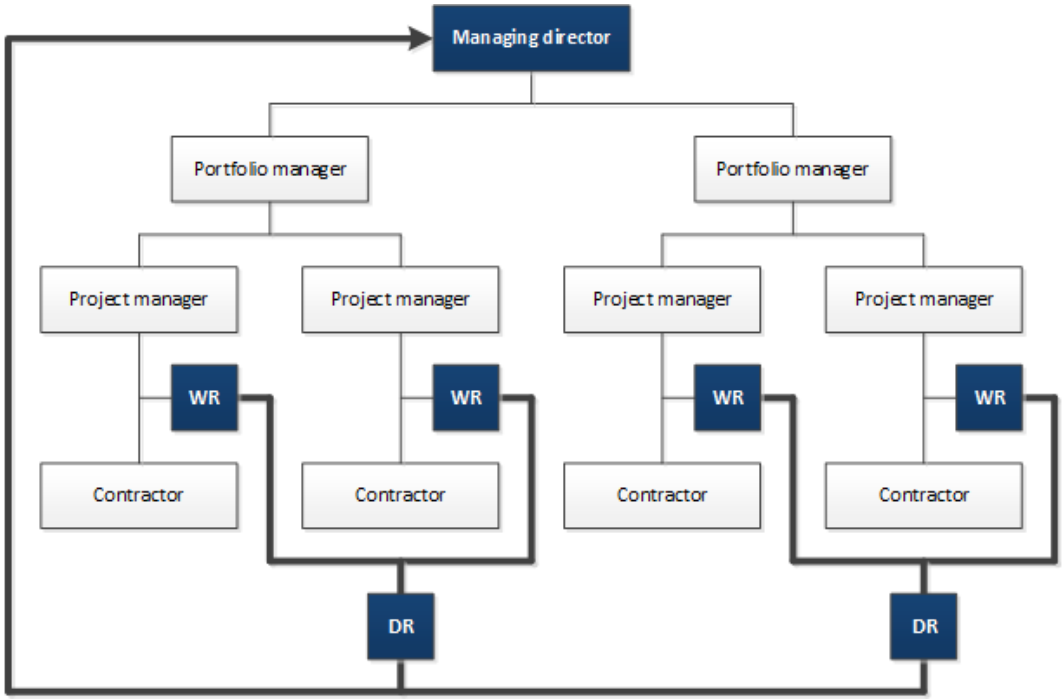

Figure 2-7: unfiltered information from project to managing director at Rijkswaterstaat

2.2.4 Conclusion

As described above, performance indicators are used in each phase of Best Value. The current use of performance indicators as described in the Best Value theory is summarised in Figure 2-8 below.

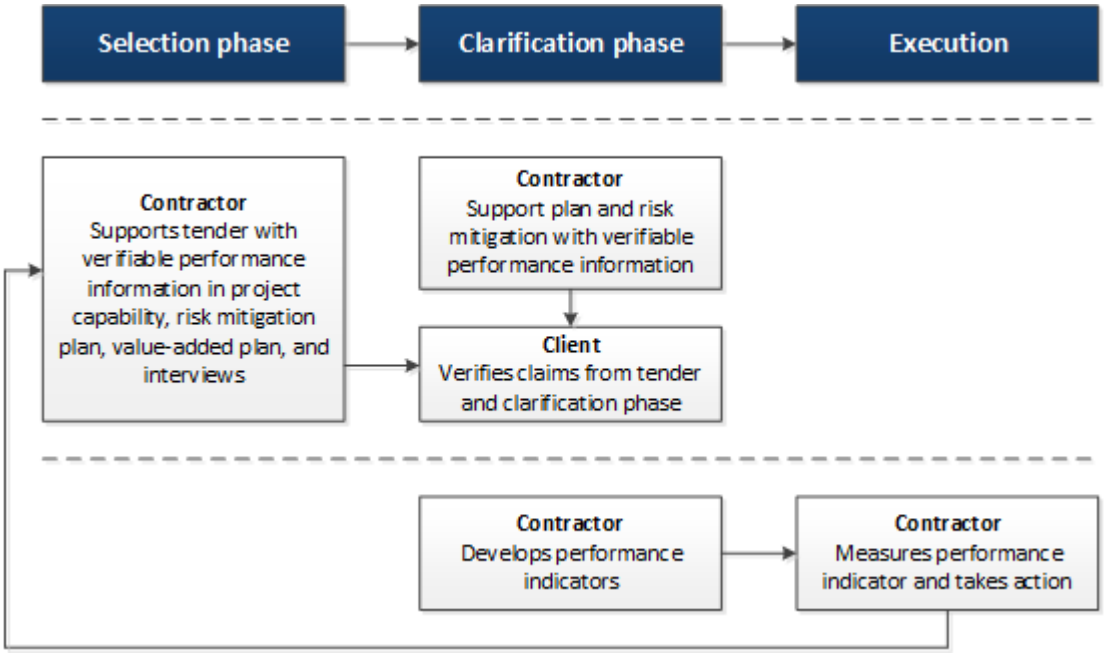

Figure 2-8: current role of performance indicators in Best Value

The contractor supports the tender with verifiable performance information. In the clarification phase, the plan is further worked out and also supported by verifiable performance information. Meanwhile, the client verifies these claims and the claims from the tender. During the clarification phase, indicators are developed for the execution of the project. During the execution, the contractor measures and takes action if needed. The measurements are communicated by the Weekly Risk Report.

However, to use performance indicators effectively, the contractor can already suggest performance indicators in his tender, to support his plans. Subsequently, the indicators can be refined by both client and contractor in the clarification phase. Both client and contractor should to these, to create support from both sides. This way, the contractor can describe in the selection phase not only the performance information from past projects, but also how he measures the performance in the current project. Suggesting performance indicators is only used in a few cases at Rijkswaterstaat. This progressive insight is shown in Figure 2-9.

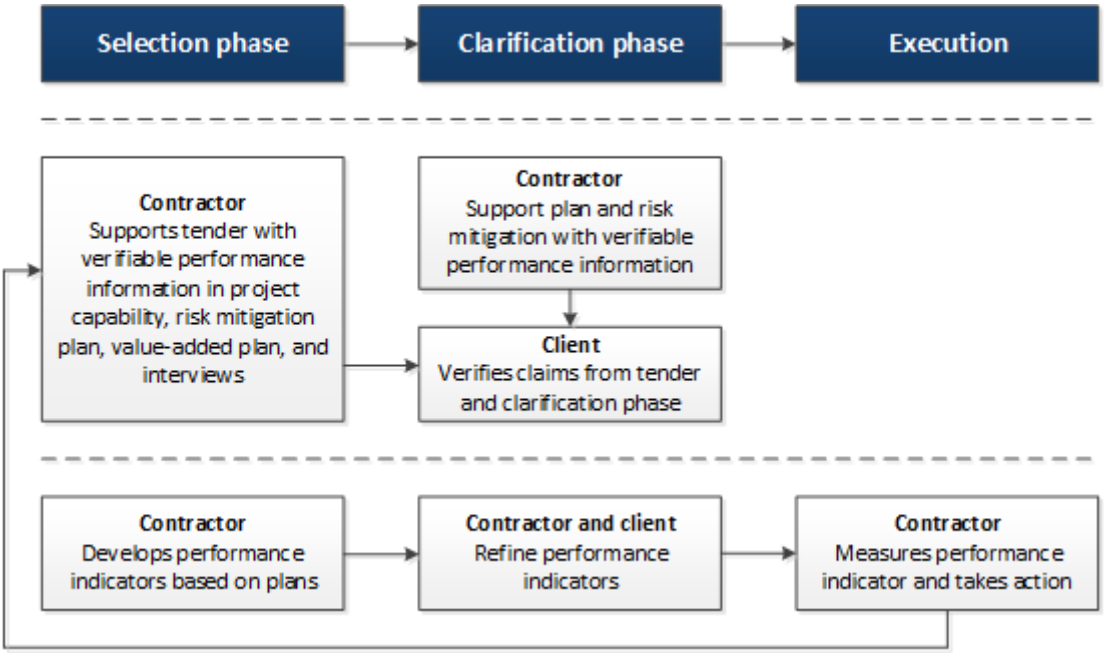

Figure 2-9: proposed role of performance indicators in Best Value

2.3 Best Value and performance indicators in theory

In this section, the role of performance indicators in Best Value is analysed from two different theories. The first theory is the Information Measurement Theory (IMT), developed by the founder of Best Value, Dean Kashiwagi. The second theory is New Institutional Economics (NIE), an economic theory that focuses on social norms, and includes concepts such as transaction uncertainty, bounded rationality, and opportunistic behaviour.

2.3.1 Information Measurement Theory

The founder of Best Value, Dean Kashiwagi, developed the approach on the base of his IMT. This theory consists of several concepts of which below the concepts of *a price-based and value-based industry*, *dominant information,* and *working in silos* are explained. The other concepts, i.e. *events* and *who is on my molecule* are described in Appendix IV.

From price-based towards value-based

In the construction industry, as well as several other industries, the focus was always on selecting a party to deliver a product or service based on the lowest price. This price-based culture led to a high competition and low prices, but also to a low performance. This is shown in Table 2-2 (quadrant I).

Table 2-2: industry structure (D. T. Kashiwagi, 2013b)

Performance: High	Perceived competition: Low	Perceived competition: High
	III. Negotiated-bid • Minimised competition • Long term • Relationship based • Supplier selected based on performance	**II. Value-based (supplier controlled)** • Buyer selects based on price and performance • Supplier uses schedule, risk management, and quality control to track deviations • Expertise and professionalism • Win-win
Performance: Low	**IV. Unstable market**	**I. Price-based (owner controlled)** • Wrong person talking • Management, direction and control • No transparency • Win-lose • Low supplier profits

A price-based culture has the following characteristics:

- Wrong person talking
  The client extensively prescribes the product or service, whilst the supplier has the knowledge.

- Management, direction and control
  The client does a lot to manage and direct the supplier and hence holds a strong control on the project, in order to let the supplier do what the client wants him to do.

- No transparency
  The strong control involves much communication and comprehensive contracts, which makes the process opaque instead of transparent. Moreover, no simple, objective performance measurements exist.

- Win-lose
  In a price-based culture, either the client or the supplier wins; the other party loses. When the client wins, he has a cheap product or service, but the supplier a high loss; when the supplier wins, he has profit, but the client pays a too high price or the product or service does not meet the expectations.

- Low supplier profits
  The strong focus on competition and lowest price makes suppliers bid lower than they actually want in order to get the project. This leads to low profits for the supplier.

Nowadays, because of the problems with the price-based culture, there is a movement towards the use of qualitative criteria in the selection, in order to achieve more value. This can be done by negotiating with a supplier about the performance and not involving price (quadrant III). This leads to a high performance, but not a high competition, and therefore the price may be too high.

Best Value aims at combining these two ways of selecting, by focusing on both price and performance (quadrant II). This so-called value-based culture has the following characteristics:

- Supplier uses schedule, risk management and quality control to track deviations
  Not the client, but the supplier controls the project, using a schedule, risk management, and quality control. The supplier tracks the deviations in achieving the project goals.

- Expertise and professionalism
  The value-based culture is based on the expertise of the supplier. The supplier is the expert and professional that "talks", instead of the client.

- Transparency
  A value-based culture means less management, direction, and control of the client. This leads to less communication. Furthermore, less management, direction and control leads to another attitude of client and contractor towards the project, other responsibilities and less contractual discussions. This all increases transparency in the process. Risk is mitigated through transparency and not management, direction and control.

- Win-win
  In a value-based culture, both client and contractor win. At the end of the project, the client has the high value product or service he asked for and the contractor has his profit, reference project, and knowledge.

Dominant information

Information Measurement Theory (IMT) states that parties have to communicate in a short, concise, non-technical, and simple way. IMT calls this type of information *dominant information*. Dominant information has the following characteristics (D. T. Kashiwagi, 2013a, pp. 3–3):

- non-disputable;
- verifiable;
- accurate;
- measurements in terms of numbers, percentages or time;
- high performance;
- shows a high probability of performance of the claim in the future.

According to Best Value, the most dominant language is the language of performance indicators. Using performance measurements and indicators, the information is understandable for everyone, including people with a low perception level. Communicating by performance indicators increases transparency, minimises the need for trust and therefore mitigates risks.

The research of Jacob Kashiwagi (2013) identified the unique factors in Best Value compared to traditional systems. The concept of dominant information, which has a strong relation with performance indicators, is one of these factors. The research under practitioners showed that 84% found this aspect unique and 73% found this

aspect led to increased value (J. S. Kashiwagi, 2013, p. 100). Therefore, the concept of dominant information can be considered as quite a unique aspect of Best Value, which has a strong impact on increased value.

Communication by dominant information and thus performance indicators are important in Best Value projects: it enables parties to communicate with each other in the supply chain in a simple and clear way, without management, direction and control, and it mitigates risks. The next section elaborates more on this communication by seeing parties as silos.

Silos in the supply chain

The supply chain of a project consists of several parties, such as the client, contractor, subcontractors, and various other stakeholders. All these parties have a certain contribution in achieving the project goals. Figure 2-10 shows the supply chain of a project.

In most projects, the parties work in silos. They only look at their own work, their own responsibilities and only do the things they have to do (inside the dashed line). Working in a silo creates opaqueness in the process, since the work is done inside the silo and the people inside the silo constantly try to protect their own silo.

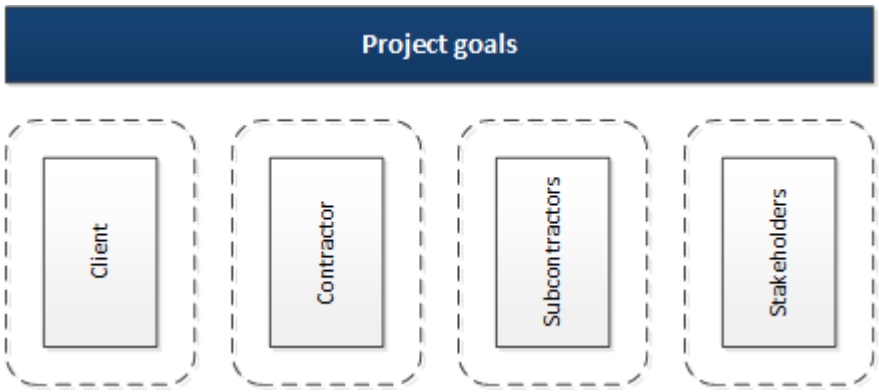

Figure 2-10: silos in the supply chain (D. T. Kashiwagi, 2013b)

Best Value aims at selecting experts that can get out of the silo and oversee the whole project. Experts do not look at their own work and responsibilities and do not think in their own interest, but they look at the whole supply chain and think in the project's interest. Moreover, to come out of the silo, transparency is needed. Best Value assumes using simplistic measurements, about their own performance, but also the performance of others in the supply chain, creates this transparency.

2.3.2 New Institutional Economics

A study done by Van Duren (2013) explains the value of Best Value seen from the perspective of the New Institutional Economics (NIE) theory. NIE is a set of economic theories, of which the Transaction Costs Economics, Property rights theory and Principal-agent theory are used by Van Duren.

NIE theories

The first theory, *Transaction Costs Economics* (i.a. Williamson (1979)), explains transaction costs and aims at reducing the sum of direct costs and transaction costs. This can be done by reducing the tendency to show opportunistic behaviour, by reducing uncertainty, and by taking account of the aspect of bounded rationality.

The second theory, *Property rights theory* (i.a. Grossman & Hart (1986)), explains the different behaviour of a party in the case when he is owner of so-called properties. Van Duren concludes that the commitment of the contractor to manage risks grows when he is risk owner, which in the end leads to project success.

The third theory, the *Principal-agent theory* (i.a. Eisenhardt (1989)), explains the relation between principal (the client) and agent (the contractor). The principal and the agent have different goals and interests and do not have the full information about each other: this is called a-symmetric information. This leads to monitoring costs for the principal: he has to ensure that the agent acts as expected and contracted. On the other hand, it leads to bonding costs for the agent: he has to convince the principal that he works in the principal's interest.

Influence on performance indicators

Van Duren concludes that Best Value promotes the alignment of goals. This leads to an increase of *"commitment, confidence and a consciousness that both parties depend on each other's performance to reduce the total costs and optimise the quality"* (Duren, van, 2013, p. 88). The use of performance measurements reduces transaction uncertainty: uncertainty whether or not the contractor will perform according to agreements and expectations made. Performance measurements contribute to transparency, objectivity, and results-oriented project management. Therefore, performance measurements reduce the uncertainty as defined in the Transaction Costs Economics.

Furthermore, performance measurements done by the contractor reduce the need for control and thus for a reduction of monitoring costs. It contributes to an efficient process without unnecessary information and therefore takes the bounded rationality of parties in account (Duren, van, 2013, p. 96).

Performance measurements also reduce the chance of opportunistic behaviour of parties. Because performance measurements can be used in next tenders, the contractor is not inclined to show opportunistic behaviour that reduces his chance in next tenders. Moreover, performance measurements contribute to conflict regulation, because objective performance information is available (Duren, van, 2013, p. 112).

In the study of Van Duren (2013), only case studies are done on the selection phase, the execution phase of a project is not taken into account.

2.4 Conclusion

Research question 1

What is the Best Value approach?

Best Value is a procurement, project management, and risk management approach aimed on getting the highest value for the lowest price, with high customer satisfaction and high efficiency. Rijkswaterstaat uses the approach slightly different from the original, American approach, due to Dutch and European legislation. The approach exists of three phases: selection, clarification, and execution. In the first phase, a supplier is selected by means of several short submittals, interviews with key personnel, and the price. The submittals and interviews should be supported by verifiable performance information. After the selection, the prospective contractor pre-plans the project and at the end of this phase, the project is awarded. During the execution, the focus is on risk management, each week reported in a Weekly Risk Report.

Best Value is based on the concepts of the founder of Best Value, Dean Kashiwagi. These concepts are called Information Measurement Theory (IMT). The concepts include a win-win situation for client and contractor, a high value for a low price, less management, direction, and control of the client, and giving contractors the space to show their expertise. It states that less management, direction and control of the client leads to more transparency and better risk mitigation. The theories of New Institutional Economics, such as transaction costs economics, property rights theory and principal-agent theory, relate the advantages of the approach to the reduction of uncertainty, taking bounded rationality into account and less opportunistic behaviour.

Research question 2

What is the role of performance indicators in Best Value projects?

This chapter showed that measuring performance is a central issue in the Best Value approach. Performance indicators are used in each phase of the process. During the selection phase, it supports the claims made in the several plans and interviews. Moreover, performance indicators can be suggested by the contractor to specify the performance to be delivered. During the clarification phase, these claims are verified and performance indicators are developed or refined for the execution phase. During the execution of the project, the indicators provide insight and transparency regarding risks and show the client and contractor's performance. Furthermore, they are the base of learning and improving during the project. Some performance indicators are already measured in the Weekly Risk Report.

In Best Value, the contractor is responsible for developing, measuring, and communicating the performance indicators, because as an expert, he is able to identify what has to be measured. He is also responsible for making risk mitigation plans in the Weekly Risk Report whenever an unforeseen event happens or is likely to happen. The contractor can use the measurements from the execution phase in a next tender as support for the claims made. Furthermore, he can use the measurement as objective base for risk allocation.

From a theoretical perspective, performance indicators also play a big role in Best Value projects. The Information Measurement Theory of Kashiwagi shows the need for transparency in the supply chain. Using performance indicators is a form of what Kashiwagi calls dominant information: verifiable, non-disputable performance information. This type of information creates transparency and risk is mitigated

through transparency. A practical study underlined the need for this type of information. From the perspective of New Institutional Economics, the need for performance measurements is also confirmed: it leads to less uncertainty, takes bounded rationality into account, and leads to less tendency to opportunistic behaviour.

This chapter highlighted the role of performance indicators in Best Value and showed that this role is considerable. However, the practical use is not clear and cannot be found anywhere in Best Value literature. A strong focus is on the first phase (i.e. selection) and hence a lack of knowledge exists in the use of indicators during the clarification phase and the execution of the project. Moreover, the role of performance indicators in the selection phase is not mentioned. Therefore, the next chapter describes the current, practical use of performance indicators.

3 CURRENT PROBLEMS WITH PERFORMANCE INDICATORS

Because chapter 2 showed a gap in the Best Value literature regarding performance indicators, this chapter highlights whether this gap exists in practice. In the first Best Value projects of Rijkswaterstaat, no performance indicators were used. However, most current projects are now obliged to use performance indicators and this chapter analyses this use. This is done by doing interviews with personnel from both client and contractor that is now involved in Best Value projects at Rijkswaterstaat (section 3.1). Furthermore, a data analysis is done on previous projects, in order to find out which party owns most risks (section 3.2). The research question below is answered in the concluding section 3.3. An overview of the structure of this chapter can be found in Figure 3-1.

Research question 3

What problems regarding performance indicators can be identified in current Rijkswaterstaat Best Value projects?

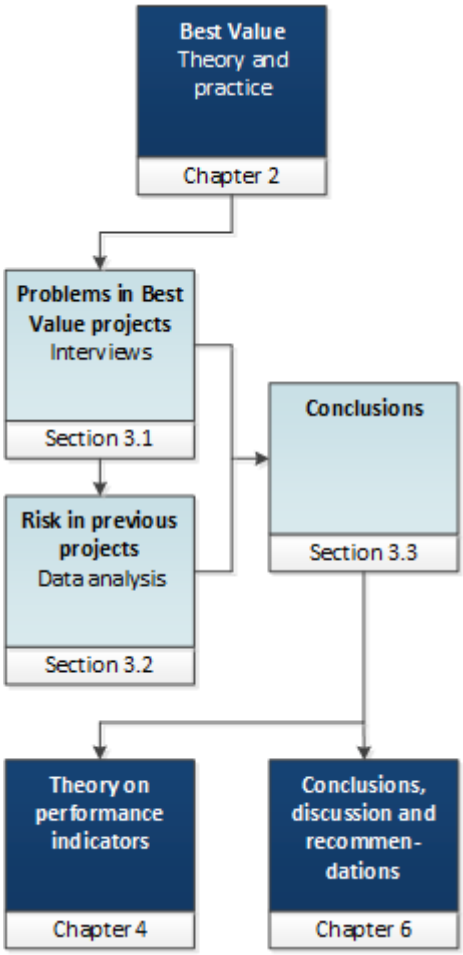

Figure 3-1: structure chapter 3

3.1 Problems with performance indicators at Rijkswaterstaat's Best Value projects

Interviews are held in order to find out the state of the current use of performance indicators in Best Value projects. This section presents this part of the research.

3.1.1 Research methodology

Goal

The problem analysis is done by holding interviews with experts from both the client and the contractor side. The aim of these interviews is to find out in a qualitative way what problems are encountered by client and contractor using performance indicators in practice. This analysis can then be used to look for improvements. This practical analysis complements with the theoretical chapter 2.

Research design

The research is conducted using individual semi-structured interviews with contract managers from the client side as well as from the contractor side. In total ten interviews are held, of which four with contract managers of Rijkswaterstaat and six with contract managers of engineering firms and general contractors. The contract managers work in six different projects: one exploration study, two planning studies, two Design and Construct contracts and one performance contract (see Table 3-1, a more extensive description can be found in Appendix V.1). In total, eight different contractors execute the projects. A broad selection of contract managers, from both the perspective of client and contractor, and analysing very different projects helps in creating a broad view of the problems regarding the use of performance indicators.

Table 3-1: cases for problem analysis

Project	Characteristics
Strengthening Houtribdijk	Exploration study for strengthening the Houtrib dike
3rd lock Beatrixsluis	Planning study for a 3rd lock at the Beatrixsluis, broadening of the Lek canal
PLuG acoustic research	Acoustic research for air and noise reduction along highways
Upgrade Zuid-Willemsvaart	D&C project for broadening and deepening of the Zuid-Willems canal
Diversion A9 Badhoevedorp	D&C project for the diversion of highway A9 at Badhoevedorp
Performance contract Droog	Maintenance project for main road network in eastern of the Netherlands

Analysis from both client and contractor's perspective is done because they both have to be helped with performance indicators, which is also stated in the research objective. Individual interviews are chosen, because the experts can give their own opinion, which is less possible in a group interview. The method of semi-structured interviews is chosen, because for the problem analysis, the room for interviewees to give their opinion, also on aspects that are not considered beforehand, is important. The interview questions can be found in Appendix VI.

The interviews are recorded and transcripts are made afterwards, in order to reduce the risk of own interpretation. The latest version of the performance indicators as used in the project is brought hardcopy to the interviews and is used as a concrete example for the problem analysis.

3.1.2 Results

This section shows the results of the interviews.

In the selection phase, it was not clear performance indicators had to be used during the project

One contractor stated that it was not clear when tendering whether performance indicators had to be used as an important aspect of Best Value. Another contractor indicated that they became aware of the need to measure during the clarification phase. One of the projects started with Best Value approach from the clarification phase. In this project, the use of performance indicators is non-contractual and the contractor was surprised by the client's attention to the use of performance indicators.

The goal of measuring performance is not made clear by the client during the clarification phase

Contractors encountered a lack of not only theoretical, but especially practical explanation about the goal of measuring performance. This lack led to less support and awareness of client and contractor for the development and use of performance indicators.

During the execution phase, this leads to indicators that are not measured because of a lack of motivation of the contractor and a lack of attention of the client. The lack of attention of the client also reduces the incentive for the contractor to measure. In other words, client and contractor have other priorities.

Not enough attention is paid by the client to the development and use of performance indicators and a lack of knowledge exists regarding the development and use

Because performance measuring is new to most contractors, they lack the knowledge to develop performance indicators, which caused difficulty in developing them during the clarification phase. Interviewees indicate that it is both hard to determine what to measure and how to make indicators measurable. During the execution, this leads to ignoring the indicators because they are either not relevant or hard to measure. Moreover, client and contractors do not always take action upon indicators when this should be required by the value of the indicator.

According to one interviewee, this led to hasty indicators at the end of the clarification phase, as part of the project management plan. Because of the time pressure in the clarification phase, indicators were made measurable without knowing whether it is easy to measure or whether it measures the right thing. An example of one of the hasty indicators developed is measures the support of the public for the project. This was done by measuring the number of negative messages in the media. However, during the project, it became clear that measuring these messages was too much time and resource-consuming and that it did not tell much about the support for the project

and therefore the indicator was no longer measured. The interviewee's on the client side agree the lack of knowledge. Practical help for developing indicators is needed.

In some of the projects, performance indicators that do not give the opportunity to steer or focus on improvement are developed. This is caused by a bad development. Examples of such indicators are the progress of investigations (chronological start-execution-end, this only shows the progress and not a performance that can be improved) or the number of reactions of the client that are too late (such an indicator can never be steered to back to zero once a reaction is given too late, therefore it does not give the opportunity to steer). In these examples, indicators like the deviation from the planning or a percentage of reaction that are too late are preferred.

In one project, the contractor started with more than twenty performance indicators, because they felt the need to measure various aspects of the project. Already after several weeks, they found out that such a high number of indicators is very time and resource-consuming to measure. Therefore, they reduced the number of indicators to fourteen by only measuring the critical aspects. Another project started with ten indicators, but during the project this is further delimited to the five most critical.

Project teams of client and contractor are hardly involved in developing the indicators

In almost all the projects studied, the development of the indicators was done and the indicators were agreed by only a few people. For example, in one project, the client was not involved at all in the development. In another project, only the project manager and contract manager of the contractor and the contract manager of the client developed the indicators, which caused a lack of support for the indicators. Therefore, one interviewee said that the indicators should be developed with both projects teams in order to create support for measuring and taking action. The indicators will be of increasing importance when the whole project team owns the indicators.

All interviewees stress the importance of the clarification phase for aligning the expectations of client and contractor, not only for the development, but also for the use during the project: when and what action will be taken?

Too much focus is on the performance of the contractor

In one of the projects, only the performance of the contractor was measured. For example, the progress on several investigations on ground and technical aspects is measured, the relation of the contractor with the stakeholders is measured, etc. No aspect of the client is measured. However, according to the Best Value theory, it is expected that most risks are owned by others than the contractor (since he is the expert) and therefore the need to measure also the client is stressed in the theory. Furthermore, a contractor only measuring his own performance reduces the attention of the client for the performance indicators.

It is hard for contractors to collect data and to determine a target value

Because performance indicators are new to Best Value projects and performance indicators are hardly used in other projects, contractors find it hard to collect data at various departments of their organisations. The interviews showed a difference in engineering services and Design and Construct contracts, and performance contracts:

the contractor of the performance-based maintenance contracts are already more used to measure performance and therefore already are able to collect data easier.

Both client and contractor agree that an ambitious target value for indicators should be agreed. Moreover, a bandwidth has to be determined to define when immediate action should be taken on an indicator. However, client and contractor hardly use performance indicators on their projects and therefore they do not know what value is ambitious and what value should be the minimum. In other words, a lack of benchmark data exists. This lack of data exists both on the client and contractor side.

Client and contractor do not know how to communicate the indicators in a clear way

At this aspect, a difference is seen between the various contractors. Two of the eight contractors use traffic light colours in their communication of the indicators (in a so-called dashboard), three use graphs to show trends, and one shows the performance using smileys (☹ and ☺). Others only show the value of the indicators. Some of the dashboards are very extensive, while others are very short and simple. This various ways of communication show that some of the contractors do not well know how to develop a clear and simple dashboard. In addition, the client does not exactly know what dashboard is useful.

Other observations

- In one case, the indicators were subjective and not verifiable. This led to a discussion about why the indicators have the value they have, instead of a discussion between client and contractor about what action should be taken upon the indicator.
- Measuring performance has an overlap with other processes of Rijkswaterstaat, such as the System-based Contract Management (SCB) and Prestatiemeten[3], and this overlap is yet unclear. This causes doubts about the need to develop and use performance indicators by all interviewees.
- The measurements that are done can be used by the contractor in a future tender. However, it is unclear whether Rijkswaterstaat may use the measurements in the selection phase of a new project. Contractors are afraid the measurements of the current project can become a disadvantage in future projects.
- Market parties were not involved when starting with performance indicators in Best Value projects, which causes a lack of motivation and distrust to the use of performance measuring.

3.1.3 Conclusion

In all stages of the Best Value process, problems with performance indicators are identified. These relate to (1) the unexpected and late introduction of performance indicators, (2) the awareness of both client and contractor of the goals of measuring

[3] Prestatiemeten (measuring performance) is a rather new instrument of Rijkswaterstaat to measure the quality of the process of collaboration between client and contractor (Rijkswaterstaat, 2012b). This research does not investigate the overlap between this instrument and Best Value.

causing a lack of motivation, (3) the lack of knowledge regarding the development and use, and (4) the availability of data and benchmarks.

Most of the problems occur in the clarification phase. The problems show that this phase is most important for the successful use of performance indicators. Moreover, many problems relate to the early phase of Best Value and the use of performance indicators. At this moment, contractors hardly use performance indicators.

In the next section of this chapter, one of the aspects of the results, namely the need to measure others than the contractor, is further researched. Earlier Best Value projects at Rijkswaterstaat enable a quantitative research into risks that occurred and which party owns the risks. The section is a further elaboration on one of the aspects mentioned during the interviews.

The interviews showed a severe lack of knowledge regarding the development and use of performance indicators. This lack of knowledge is the base of most of the problems regarding performance indicators in Best Value projects. Therefore, chapter 4 and 5 further research this lack of knowledge. The other problems found in the interviews will not be further researched because of the limited time available for this research. Nevertheless, they will be part of the conclusions and recommendations in chapter 6.

3.2 Risks in previous projects

Best Value aims at selecting the expert contractor. It assumes that the risks of this contractor within his own influence area are very low: an expert knows what to do. Therefore, the main risks are outside the influence area of the contractor and are mainly owned by the client. However, as concluded in section 3.1, many performance indicators are linked to the performance of the contractor. In the light of Best Value, it therefore also seems important to connect indicators to the performance of the client. This section describes the data analysis done to prove the assumption that most risks are owned by the client.

3.2.1 Research methodology

Every Best Value project at Rijkswaterstaat uses Weekly Risk Reports, as described in section 2.2.3. In this case, all the final Weekly Risk Reports, containing all the risks that happened during the projects according to the contractor, are analysed. For each risk, the real impact on time and cost is described by the client. Moreover, the owner of the risk (client, contractor or unknown) is described; however, this is not always determined in the same way in different projects. Therefore, each risk is individually analysed and the risk owner is determined. Only risks that had a negative impact on the project in terms of time or budget are analysed, since these risks had a negative impact on the project.

3.2.2 Case description

The case in this research is the Spoedaanpak (Fast Track) programme, a programme aimed at quickly resolving major bottlenecks on the Dutch highway network. The Road Projects (fast-tracked decision-making) Act and the Crisis and Recovery Act,

together with an innovative parallel approach, made it possible for Rijkswaterstaat to shorten procedures and start on short-term with the execution.

The programme, initiated by the former Minister of Transport, Public Works and Water Management Camiel Eurlings, includes thirty projects. Sixteen of these projects are approached with Best Value: by the time the biggest Best Value pilot worldwide and the first Best Value projects of Rijkswaterstaat. The projects were mostly awarded between the end of 2009 and mid-2010. By March 2013, fourteen of the sixteen projects were finished; the other two are in a very advanced stage and will be finished soon. An overview of the projects can be found in Appendix VII.

The goal of the programme was to resolve quickly major bottlenecks on the Dutch highways; therefore, during the projects a lot of focus was on on-time completion. The bottlenecks are resolved by better utilisation of the current road (using managed motorways, Dutch: spitsstroken) and widening the current road. Therefore, the projects are executed at or next to existing infrastructure, instead of building a new highway at unknown ground. Not only asphalt had to be paved, also Dynamic Traffic Management systems had to be installed and in one project, a bridge had to be built.

3.2.3 Results

In total, 277 risks in sixteen Best Value projects had an impact on cost or time. The parties that own these risks are shown in Table 3-2. The risks occurred, as well as the occurrence and the impact on time and cost can be found in Table 3-3.

The results show that parties other than Rijkswaterstaat and the contractor owned risks. However, these parties are not in the influence area of the contractor and therefore Rijkswaterstaat is the risk owner.

Table 3-2: risk owners of Spoedaanpak

Party	Occurrence	%	Extra costs %	Extra time %
Rijkswaterstaat *Project teams, departments, road districts, traffic centrals*	245	88.4%	90.3%	57.4%
Provinces	2	0.7%	0.1%	0.0%
Water boards	3	1.1%	0.5%	0.0%
Municipalities	4	1.4%	0.4%	0.0%
Stakeholders in the environment *E.g. a gas company, the planning authority, cables and pipes managers*	19	6.9%	8.3%	25.0%
Rijkswaterstaat	**271**	**98.6%**	**99.5%**	**82.5%**
Contractors	**4**	**1.4%**	**0.5%**	**17.5%**
Total	277	100.0%	100.0%	100.0%
Total compared to planning			*18.2%*	*9.6%*

Table 3-3: results of data analysis Spoedaanpak

Category	Occurrence	% / total extra costs	% / total extra time
Extra requirements and change orders of client and stakeholders during the project *E.g. extra noise barrier, extra banners for public, change in the design because of a stakeholder, extra asphalt maintenance outside the scope, extra glass fibre cables, another type of asphalt has to be paved.*	83	29.6%	7.2%
Quality of existing infrastructure at a worse level than known *E.g. Existing water pipe is not strong enough, existing culvert is not strong enough, overdue maintenance, current road profile does not comply with requirements.*	27	11.4%	9.4%
Other *E.g. compensation from client regarding rising prices, bank guarantees needed, payment from client not in time, rent of offices for project organisation.*	27	11.6%	13.4%
Traffic management *E.g. temporary portal for traffic needed, extra traffic guards hired because of unsafe situation, extra signing.*	24	4.1%	0.0%
Soil pollution *E.g. asphalt containing tar found, polluted soil found, unexpected soil pollution at tank station.*	17	2.5%	0.0%
ICT *E.g. extra requirements concerning Dynamic Traffic Management, changes in bridge system after accident elsewhere, insufficient capacity of glass fibre cable.*	15	1.0%	2.3%
Incorrect demand specification *E.g. incomplete requirements, extra work needed which should have been explained in demand specification, legal replanting of trees not in demand specification.*	14	3.2%	0.0%
Cables and pipes *E.g. cables and pipes not in time diverted, unknown polluted pipe found, gas pipe not at expected place.*	14	3.0%	15.3%
Technical problems *E.g. extra ladder needed to reach bridge pier, extra monitoring of bridge, extra reinforcement of bridge needed.*	11	4.1%	0.0%
Permits *E.g. the lack of a building permit, the lack of a permit to cut trees, extra water compensation needed because of Water Act.*	11	3.6%	8.0%
Regulations *E.g. new rules concerning signage, higher noise barriers because of client regulation.*	9	8.8%	32.4%
Incorrect planning decree *E.g. conflicting requirements in planning decree, water management not possible in accordance with planning decree.*	5	0.8%	2.4%
Documents between client and contractor	4	2.3%	1.9%

E.g. plan received too late from client, documents of a civil work are not correct.			
Risks related to other projects *Work delayed because other project is not finished.*	3	7.4%	3.7%
Nature *E.g. extra tree planting, measures because of finding of badger burrow.*	3	0.4%	0.0%
Archaeological findings *E.g. extra archaeological research because of Monument Act, old dike found.*	3	0.4%	0.0%
Regulation of others *Bridges have to be widened because of new regulation of knowledge institute, compliance with new European directive.*	2	5.8%	0.0%
Land acquisition *Landowner not willing to sell land, landowner did not leave within time.*	2	0.1%	0.0%
Weather conditions *Delay of unexpected bad weather conditions*	2	0.0%	4.0%
Unexploded explosives *Extra research for unexploded explosives.*	1	0.0%	0.0%
Total	**277**	**100.0%**	**100.0%**
Compared to contract time and price		**18.2%**	**9.6%**

As can be seen in Table 3-2, more than 88% of the risks are owned by the client (the several parts of Rijkswaterstaat's organisation). More than 10% of the risks are owned by other parties, but as mentioned above, these risks are also owned by the client. Therefore, Rijkswaterstaat owns 98.6% of the risks. 1.4% of the risks are owned by the contractor. When looking at costs, the risks are even more owned by the client. Regarding extra time, the stakeholders in the environment and the contractors had much influence.

3.2.4 Analysis

Table 3-2 clearly shows that most risks in these sixteen projects are owned by the client, and that these risks have a great influence on cost and time. Most of these risks (see Table 3-2) are related to extra requirements and change orders (83, 30.0%), and to a worse quality level of the existing infrastructure than expected (27, 9.7%). Meanwhile, the contractor owns only a few of the risks.

3.2.5 Conclusion

This analysis of sixteen projects shows that the most of the risks (277 in total) are owned by the client (98.6%) and that the contractor owns very few risks that influence the project negatively on time or cost (1.4%). Therefore, this analysis confirms the assumption made in Best Value that it is important for the contractor to measure others than himself, because the others threaten the achievements of the goals on time and cost.

The researched cases are all part of one program and only involve highway broadening and optimisation, since Best Value is still in an early phase and therefore no other projects are available. However, the distribution of risks is so clear that it is very likely that the client owns a large part of the risks in the other projects too.

From this conclusion, one may wonder why the contractor has to measure, if the majority of risks in the projects are owned by the client. However, this is contrary to the theory of Best Value, where the contractor is seen as the expert. In this expert role, the contractor developed his plan during the selection and the clarification phase and hence it is the plan of the contractor that is executed. The expert contractor knows the risks of his plan better than the client and therefore he knows what to measure, how this can be measured, and how action can be taken when needed. In other words, the contractor is still the best party to use performance indicators, even if they relate to the performance of the client.

3.3 Conclusion

Research question 3

What problems regarding performance indicators can be identified in current Rijkswaterstaat Best Value projects?

This first part of this chapter described the problems that both client and contractor encounter while developing and using performance indicators in Best Value projects.

In each phase of the project, the client as well as the contractor found it hard to work with performance indicators. The problems relate to (1) the unexpected and late introduction of performance indicators, (2) the awareness of both client and contractor of the goals of measuring causing a lack of motivation, (3) the lack of knowledge regarding the development and use, and (4) the availability of data and benchmarks.

The second part of this chapter zoomed in on of the aspects from the interviews: the question whether the client or the contractor has to be measured. This is a more in-depth, quantitative analysis of this problem. Data analysis clearly showed that almost all risks in Best Value projects that have an impact on time or cost are owned by the client. Therefore, it is important for the contractor to measure also the performance of (the risks of) the client, which is hardly done at this moment. Even though it is the client's performance that is measured, the contractor has to measure and take action, since he is the expert and therefore knows the best what to measure, how to measure, and how to take action if needed.

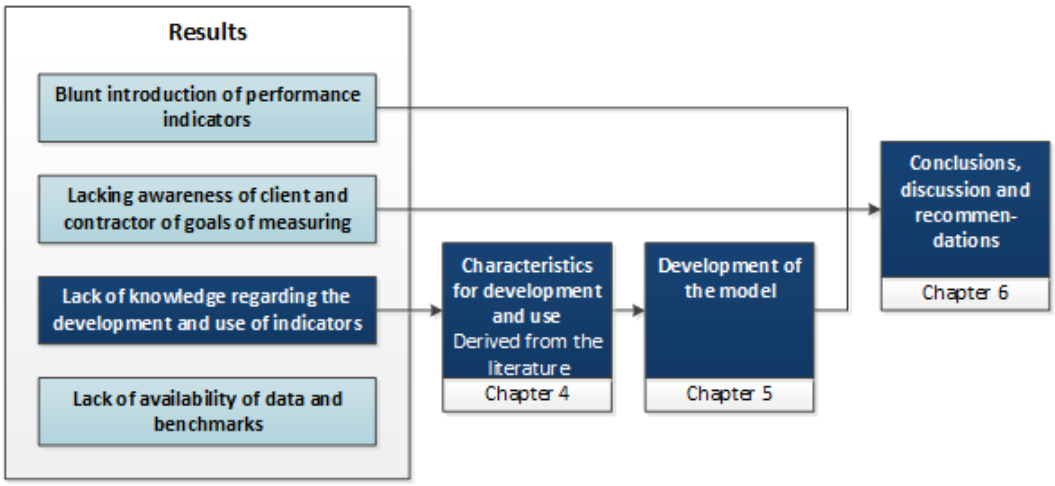

Figure 3-2: further delimitation of this research

Because the interviews showed that the problems encountered in many cases relate to the lack of development and use of performance indicators, and the gap in Best Value literature regarding this subject (chapter 2), this aspect is further researched. Chapter 4 gives an overview of the literature available on this subject. Subsequently, in chapter 5, a model is made for the development and use of performance indicators in Best Value projects. The delimitation is schematically shown in Figure 3-2.

The problem of the blunt introduction of performance indicators is not further researched, because in the meantime, Rijkswaterstaat changed their explanation of Best Value and performance indicators to market parties. Before and during this research, they improved their communication of their expectations regarding performance indicators. Moreover, they made performance indicators contractually mandatory. Although the effect of these actions is not researched, it is expected that the unexpected and late introduction of performance indicators is no longer a problem.

The other problems found in the interviews (i.e. the lacking awareness of the goals and lack of availability of data) will not be explicitly further researched due to the limited time available for this research. Nevertheless, they are part of conclusion and recommendations in chapter 6.

4 PERFORMANCE INDICATORS IN THE CONSTRUCTION INDUSTRY

This chapter gives a literature overview of performance indicators in construction industry and aims at finding solutions for the problems as described in chapter 2 and 3. The chapter starts with the applicability of performance indicators in the construction industry in section 4.1. After that, the problems when first implementing performance indicators are described (section 4.1.4). Subsequently, section 4.3 focuses on characteristics for developing and using performance indicators. In this section, literature is studied on aspects that can fill the knowledge gap and solve the problems as described in chapter 2 and 3. This chapter ends with the conclusion in section 4.4, which answers the research question below.

Research question 4

How are performance indicators generally used in the construction industry?

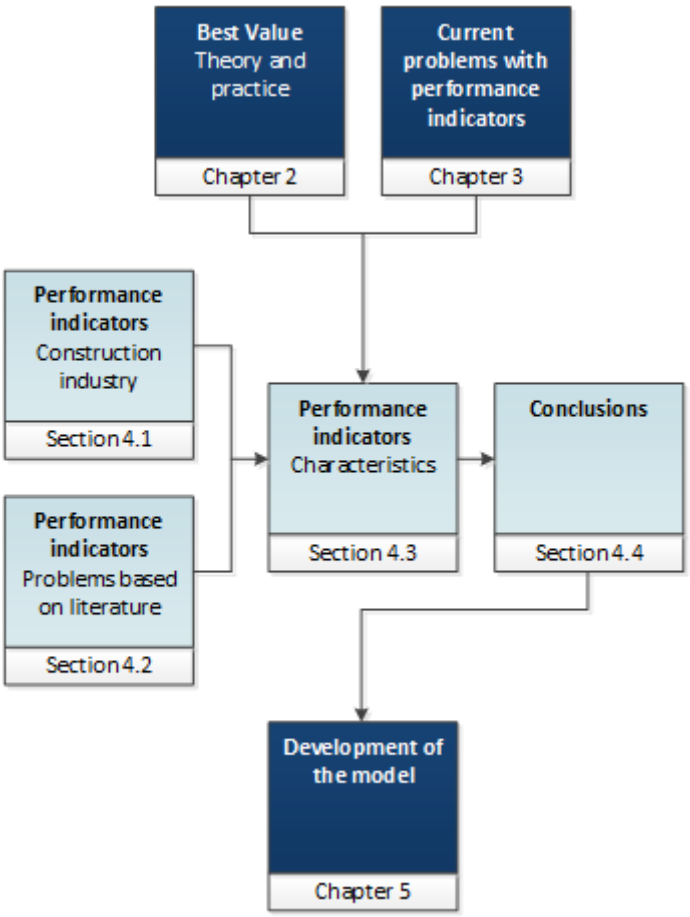

Figure 4-1: structure chapter 4

In this research, both the terms performance measurement and performance indicator is used. Performance measurement is only the measurement in itself, while

a performance indicator is a clear description of why, how and what is measured, how this measurement relates to the baseline, and what action has to be taken.

4.1 Applicability in the construction industry

The construction industry is known for its low performance compared to other industries (Vrijhoef, 2011). The main reasons stated in the literature for this low performance are the complex nature of building projects, the existence of many disciplines and stakeholders, the fragmented processes in the project, and the uniqueness of each project. In the last years, this has led to several attempts for improvement. One of these attempts is the use of performance indicators.

4.1.1 Performance indicators in general

Using performance indicators is a well-known business management concept nowadays. It is used in both organisations and projects, since a project is eventually an organisation in itself. Neely (1998) identified four functions of using performance indicators in organisations:

- Checking
  Performance indicators establish the current status and monitoring of progress over time and against benchmarks.
- Communicating
  Customers, employees, and marketing expect performance indicators.
- Confirm priorities
  Performance indicators provide insight to what is important to an organisation.
- Compel progress
  Performance indicators help the organisation focus on specific issues and encourage people to change and improve performance.

Another study about why to measure performance is done by Behn (2003). He identified eight purposes that public managers have for measuring performance, including evaluate, control, budget, motivate, promote, celebrate, learn, and improve.

Performance indicators in other industries are mainly used to assess the organisation's performance. The performance there is measured over a long period, using mainly a common set of indicators, combined with some organisation-specific indicators that are not likely to change. The next section focuses on performance indicators in construction projects.

4.1.2 Performance indicators in the construction industry

As stated earlier, a construction project is characterised as complex, fragmented, and unique. These characteristics require a slightly different way of using performance indicators, which is described below.

Complexity

Knowledge from various disciplines is needed to finish the projects. Moreover, many stakeholders have an interest in the project. These stakeholders include not only the client, the contractor, and his subcontractors, but also other governments, end-users, local residents, NGOs, etc. The number and kind of disciplines and stakeholders vary however per project. Since all disciplines and stakeholders are part of the project, the indicators have to represent somehow these disciplines and stakeholders, in order to be supported. Therefore, a common, generic set of indicators can only be applied partly in construction projects.

Fragmentation

A construction project is a process that consists of various phases. These phases, such as the pre-project phase, design phase, and construction phase, are interdependent but also very different in nature. Therefore, the performance indicators have to be tailored to each phase, instead of using one set of indicators during the whole project.

Uniqueness

Although many construction projects are in some way similar, they all have certain uniqueness, because of for instance unique ground and weather conditions, specific user requirements and special stakeholders. This uniqueness means that a generic set of indicators that can be used in every project are partly applicable; project-specific indicators are also needed.

The characteristics above show that the use of performance indicators in construction projects is different from their use in other industries. While other industries measure on a long-term, with a standardised set of indicators, performance indicators in construction have to be subject to change over several phases and have to be partly project-specific. Although this makes the indicators less applicable for the *checking* function (long-term monitoring against industry benchmarks), the indicators fit better with the complex, fragmented, and unique nature of construction projects.

Example of industry-wide benchmarking

Several initiatives of a construction industry-wide comparison on performance indicators exist. An example from the United Kingdom is the UK Construction Industry KPIs (Key Performance Indicators) (Constructing Excellence, 2006). This handbook stems from the Rethinking Construction report of Egan (1998) and aims at improving construction performance by benchmarking the UK construction industry. Besides from the handbook, a KPI database and benchmarking tool is available (CCI, 2010). An example of this benchmarking tool can be found in Figure 4-2. In such a figure, a contractor can trace their position in the market on a specific indicator, in this case *client satisfaction*. The contractor can see the percentage of companies that have a better or worse client satisfaction than him.

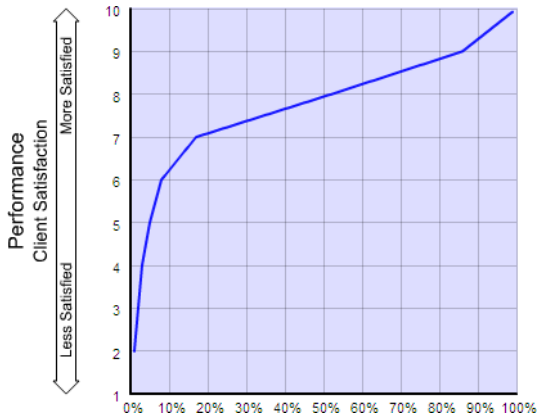

Figure 4-2: example of benchmark on client satisfaction (retrieved from KPI Engine (CCI, 2010))

The indicators in the benchmarking tool are divided into several categories, such as *economic*, *new build housing*, and *infrastructure*. This last category seems suitable for this research and includes indicators such as *construction time*, *client satisfaction of the product*, *client satisfaction of the process*, and *the number of defects*. In total, 21 indicators are included in this specific tool. However, indicators from other categories can be used too if the project is specifically aimed on such a category. Examples of these indicators include *safety*, *profitability*, *employee satisfaction*, *sickness*, *energy use*, *impact on biodiversity* etc. At the end of this section (4.1.4), the usefulness of these indicators in Best Value projects will be analysed.

4.1.3 Types and examples of indicators

Over the years, performance measurements became increasingly popular. This also led to a lot of literature on this subject, including a wide variety of performance indicators. This section briefly describes some of the various types of performance indicators.

Traditionally, performance indicators in organisations are mainly about financial aspects, although many studies show that these aspects are no longer sufficient, as they do not stimulate continuous improvement and innovation. Kaplan & Norton (1992) address the need for a mix of financial and operational indicators. They come with four perspectives for goals on which the indicators should be linked, namely a customer perspective, an internal perspective, an innovation and learning perspective, and a financial perspective.

Atkinson (1999) calls the financial criteria, together with time and quality, the *"iron triangle"*, and concludes that these three criteria alone should not be the only project management criteria that have to be measured. Neely (1999) argues that financial indicators encourage short-termism, lack strategic focus, and fail to provide data on quality, responsiveness and flexibility, encourage local optimization, and do not encourage continuous improvement. Toor & Ogunlana (2010) conclude that construction projects are slowly moving away from traditional indicators towards a mix of qualitative and quantitative indicators.

Ghalayini & Noble (1996) as well as Kagioglou, Cooper & Aouad (2001) make a distinction between lagging and leading indicators. Lagging indicators are indicators that indicate results in the past. These indicators give little possibility to improve the

performance. This is contrary to leading indicators; these indicators give an opportunity to steer. This is agreed by Haponava & Al-Jibouri (2009), who urge the need for process-based indicators. Examples of lagging indicators are financial indicators such as *total costs*, which only tell something about the outcome; an example of a leading indicator is *client satisfaction*, since this indicates the quality of a process and changing the process can influence the indicator.

Cox, Issa & Ahrens (2003) see two types of indicators: qualitative and quantitative. Quantitative indicators are indicators that can be physically measured and that do not place a heavy burden on the field personnel. Examples of quantitative indicators are *percent complete* and *total rework*. Qualitative indicators are indicators that are less easy to measure. Examples of qualitative indicators are *safety* or *absenteeism*.

Beatham, Anumba & Thorpe (2004) make a distinction between three types of indicators: Key Performance Indicators (KPIs), Key Performance Outcomes (KPOs), and perception measures. In their research, they see KPIs as performance measures that indicate the performance of an associated process. This indication provides an opportunity to change and to take corrective action. An example of a KPI is the *number of complaints of road users*, which may indicate a low performance in limiting the nuisance of the work. On the other hand, KPOs are considered as the results of a completed process, which means that they do not offer the opportunity to change. They can be used to change the next process, but the results of the current process cannot be changed. An example is *total overrun in days*, which quantifies the outcome of the performance. The third type of indicators is perception measures. They are measures that measure the perception of people and they are carried out by direct question or survey. Perception measures can be used both during the project and at the end of the project. An example of a perception measure is *client satisfaction*.

Finally, Chan & Chan (2004) make a distinction between objective and subjective indicators. The first type can be calculated using mathematical formulas. The second type is based on subjective opinions and personal judgement of the stakeholders. Objective indicators include *construction time*, *net present value*, and *accident rate*, whilst subjective indicators include *quality*, *client satisfaction*, and *end-user satisfaction*.

Concluding from the overview above, other indicators than time, cost, and quality are of importance. Moreover, several scholars advocate performance indicators that enable to steer during the process.

4.1.4 Impact of Best Value on these indicators

The last three sections showed a wide range of indicators, mostly generic indicators that can be used in every project. However, the specific characteristics of construction projects (i.e. complex, fragmented, and unique) showed also the need for partly using project-specific indicators, in addition to generic indicators. Generic indicators can be used for company-wide and industry-wide comparison, which is less possible with project-specific indicators. Meanwhile, project-specific indicators can be more effective when closely steering on specific, important aspects of a project.

Best Value has an influence on the use of performance indicators in general infrastructural construction projects. As described in chapter 2, the contractor is

responsible for developing and measuring the indicators. The goal of these indicators is to show the performance of important aspects of the project in a dominant, transparent way to the client. These important aspects are the project goals and the risks that threaten the achievement of these project goals. To a certain extent, these project goals are generic. Examples of such project goals are finishing the project within time and budget and satisfying the client. These indicators are also measured in the Weekly Risk Reports, but other generic indicators may exist.

However, a part of the project goals is unique for the project itself or unique for the phase of the project. Moreover, the risks of a project are mainly project-specific. Because Best Value stresses the need to measure the performance on the project goals and to measure the performance of mitigating the top risks of the project (risk is mitigated through transparency and thus with performance indicators), performance indicators in Best Value projects are much more project-specific. For example in a project of building a tunnel, the generic indicator *profitability* is important for the contractor to measure, but is not directly connected to a project goal or top risk and is therefore less important to communicate according to the Best Value approach. However, a top risk of the project (as indicated by the expert contractor) can relate to the integration of the safety system in the tunnel. An indicator that measures the performance of this integration gives transparency regarding this top risk and enables the contractor to steer closely on this risk and hence mitigate the risk.

The Weekly Risk Report, the expert role of the contractor, the measurements he conducts, and the focus on transparency and risk mitigation are unique for Best Value and therefore, project-specific indicators play a bigger role in Best Value projects compared to general infrastructural construction projects. Therefore, a model will be designed to help in the development and use of performance indicators in Best Value projects.

4.2 Problems with performance indicators

When performance indicators were first implemented in the construction industry, the focus was on industry-wide comparison. However, there is a shift towards the internal improvement of a construction company. There were several problems when first implementing performance indicators (Beatham et al., 2004):

- they focused on lagging performance outcomes, instead of leading indicators, at a very high level that offered little opportunity to change;
- they were not aligned to objectives of construction companies;
- they were designed for cross-industry benchmarking purposes, however, problems with different procurement routes and a lack of validation made the results not verifiable;
- they did not provide a holistic representation and did not cover all criteria;
- they were not incorporated into a performance measurement system.

From these problems, some requirements can be derived. First, the indicators have to be leading; they have to provide an opportunity to change during the process. This is also found in the section 4.1.2. Second, they have to be aligned with objectives of the organisation. This is also agreed by Collin (2002), who stated that the indicators have

to be accepted, understood, and owned across the organisation. More on the connection with the vision can be found in section 4.3. Third, they not have to be too focused on industry-wide comparison, a conclusion that is also taken earlier this chapter and that also is agreed by Toor & Ogunlana (2010). Fourth, they have to cover all the project goals. Last, they have to be part of a system with feedback and action.

4.3 Characteristics from the literature

This section describes the characteristics for the development and use of performance indicators in Best Value projects, according to the literature, and describes how these characteristics are found. Some of these characteristics are already described in the previous sections of this chapter, but are now used in a more extensive literature analysis.

4.3.1 Research methodology

In order to find characteristics suitable for Best Value projects in the construction industry, literature is analysed. As this research focuses on infrastructural construction projects, mainly literature on this subject is sought. In addition, project management literature is used, because this is also applicable to construction projects.

The keywords used to find relevant literature include *performance indicators*, *performance measurement*, *performance measuring*, *performance metrics*, *construction*, and *infrastructure*. These are all keywords that are used or that are derived from the research objective and questions. Because much literature exists on these subjects, papers are sorted by the number of citations. The number of citations is used to indicate the level of quality of the publication. Moreover, the journal in which the paper is published is taken into account. Relevant journals include *International Journal of Project Management*, *Benchmarking: An International Journal*, and *Construction Management and Economics*. Because the indicators have an overlap, the number of sources is chosen to be limited to twelve. As concluded in chapter 2, no literature on this subject in combination with the Best Value approach exists.

4.3.2 Results

The characteristics that are found in this literature are described in Table 4-1 and further worked out below. These characteristics, shown in the non-shaded fields, are very comprehensive and varying, but also have a lot of overlap. Therefore, similar characteristics are combined to a set of sixteen characteristics, shown in the shaded fields.

Table 4-1: characteristics from the literature

Few in number	Balanced and cover the project	Focus on improvement
Few in number, low number of indicators, handful, most critical, no more than fifteen, limited, manageable amount	Balanced and linked, holistic, cover criteria	Predictive, leading, base for improvement

Standardised	**Reinforced with incentives**	**Simple**
Standardised	Reinforced with incentives	Easy to understand, simple, understood, easy to gather, easy to apply, automated, no bureaucracy, use technology, easy to use and update, not placing heavy burden on field personnel, systematic use
Specific	**Measurable**	**Context driven, target and bandwidth**
Specific, accurate	Measurable, clear formula	Context driven, attainable, benchmark, target
Aligned with goals / relevant	**Time-bound**	**Verifiable**
Relevant, aligned with objectives, purpose, relate to objectives	Timely, time-bound, frequency	Verifiable, source of data
Owned by someone accountable	**Actionable**	**Visual communication**
Owned, commitment, who acts on data	Actionable, trigger changes, part of system	Dashboards, display results and trends, graphic displays
Evaluation		
Periodical refresh, evaluation per phase, refine		
References used: Eckerson (2006, p. 201), Kerzner (2011, p. 104), Haponava (2009, p. 168), Constructing Excellence (2006), Yuan, Zeng, Skibniewski & Li (2009), Kaplan & Norton (1992), Atkinson (1999), Collin (2002), Beatham et al. (2004), Neely, Richards, Mills, Platts & Bourne (1997), Cox et al. (2003), Chan & Chan (2004)		

Table 4-2 shows again the sixteen characteristics, but they are now divided per reference (the twelve columns). A dot (●) in a cell means that the characteristic in the accessory row is retrieved from that reference.

Table 4-2: characteristics divided per reference

Characteristics	1	2	3	4	5	6	7	8	9	10	11	12
Few in number	●	●		●	●	●	●	●				
Balanced and cover the project	●					●			●			
Focus on improvement	●	●	●	●					●			●
Standardised	●											
Reinforced with incentives	●											
Simple	●	●	●	●				●		●	●	
Specific			●							●		
Measurable		●	●							●		
Context driven, target and bandwidth	●					●				●	●	●
Aligned with goals / relevant	●	●	●						●	●		
Time-bound	●									●		
Verifiable									●	●		
Owned by someone accountable	●			●				●		●		
Actionable	●	●		●					●	●		●
Visual communication				●				●				
Evaluation	●							●				

1. Eckerson (2006, p. 201), 2. Kerzner (2011, p. 104), 3. Haponava (2009, p. 168), 4. Constructing Excellence (2006), 5. Yuan et al. (2009), 6. Kaplan & Norton (1992), 7. Atkinson (1999), 8. Collin (2002), 9. Beatham et al. (2004), 10. Neely et al. (1997), 11. Cox et al. (2003), 12. Chan & Chan (2004)

Below, the sixteen characteristics are further explained.

Few in number

For a successful implementation of a performance measurement system, the number of indicators should be kept low (Yuan et al., 2009). Kaplan & Norton (1992) speak of a handful, most critical performance indicators, Atkinson (1999) states no more than fifteen and Collin (2002) says that in order to keep the indicators maintainable and not too time- and resource-consuming, a limited, manageable amount should be used.

Balanced and cover the project

A balanced, holistic set of indicators has to be developed, which covers the project goals (Beatham et al., 2004). There has to be a good mix of client and contractor indicators, a good mix of indicators related to project performance and risk performance, and the indicators should not undermine each other (Eckerson, 2006).

Focus on improvement

As described in section 4.1.2, indicators should be predictive and leading, i.e. they have to give the opportunity to steer, instead of only telling something afterwards (Haponava, 2009). This way, the indicators are the base for improvement. By using

leading indicators, they *"can be used to give an early warning, identify a potential problem and highlight the need for further investigation"* (Beatham et al., 2004, p. 106).

Standardised

Eckerson (2006, p. 201) states that performance indicators have to be standardised, so *"they can be integrated across dashboards throughout the organisation"*. However as stated before, project-specific indicators are more common in Best Value projects and the model focuses on developing and using these project-specific indicators. Therefore, this aspect is left out in this part of the research.

Reinforced with incentives

Performance indicators can be reinforced with incentives, such as payments when an indicator is at the target value. However, Eckerson (2006, p. 201) warns that this should only be done to well-understood and stable performance indicators. With more project-specific indicators in Best Value, as described in section 4.1.4, such incentives seem less applicable. In Best Value, the incentive of the indicators is that a contractor may use the measurements in a future tender, to distinguish himself amongst his competitors. Other incentives, such as a connection with the payments to the contractor, are not done at Rijkswaterstaat. Therefore, this characteristic is also left out further on.

Simple

A simple, easy-to-understand indicator is important to increase transparency, reduce discussion about the indicator and keeping the resources needed to measure low. Kerzner (2011, p. 104) states that indicators *"should be straightforward and easy to understand"*. Cox et al. (2003) stress that indicators should be easy to gather, should be easy to apply, and should not place a heavy burden on field personnel. The KPI Handbook of Constructing Excellence (2006) advocates simplicity and no bureaucracy.

Specific

Indicators should be specific. Specific is one of the SMART requirements. Indicators should describe clearly what is measured and how this is calculated. This reduces discussion. Neely et al. (1997, p. 1136) describe the title of the indicator as *"one that explains what the measure is and why it is important. It should be self-explanatory and not include functionally specific jargon"*.

Measurable

A measurable indicator makes it possible to compare the indicators over time and with others. Moreover, using a formula keeps the indicator objective and verifiable. A simple formula increases transparency. Neely et al. (1997) state that a measurable indicator with a clear formula is one of the most challenging elements to specify, because it affects how people behave: making an indicator measurable in a certain way may create an unwanted incentive. Therefore, caution is needed when making an indicator measurable.

Context driven

Context driven is described as having a target, bandwidth, or benchmark. Kerzner (2011) addresses the need for a target and bandwidth. Cox et al. (2003) say that a

historical baseline can be used as a change for improvement. Kaplan & Norton (1992, p. 74) describe a benchmark as a *"technique to compare their performance against competitor's best practice"*. Beatham et al. (2004) state that benchmarking is key to adding value to performance measurements.

Experience is required to know the benchmark. When using project-specific indicators, benchmarking is harder and decision are more based on intuition (Chan & Chan, 2004).

Aligned with goals

In order to make sure that performance measurements are not meaningless, they have to be part of a performance management system. This system consists of reviewing the performance, deciding on actions, and changing the way in which the organisation operates (Beatham et al., 2004). According to Bititci, Carrie, & McDevitt (1997), the performance management process is a closed loop control system, schematically shown in the left side of Figure 4-3.

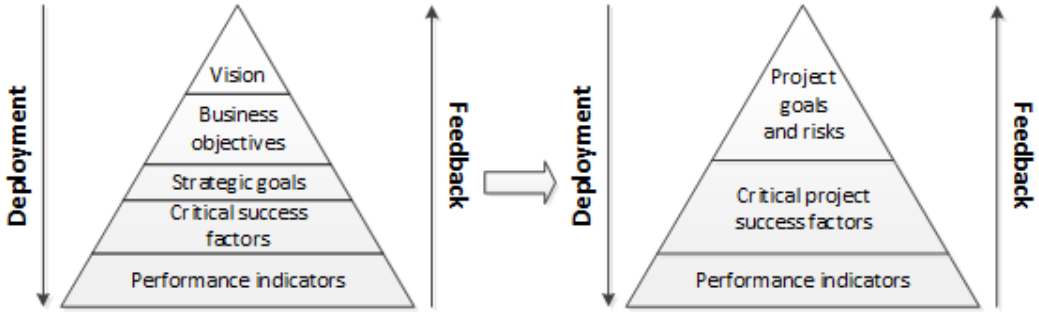

Figure 4-3: performance management process (based on Bititci et al., 1997)

The organisation's vision is on top of the triangle. This vision is deployed into the organisation through business objectives, strategic goals, critical success factors, and, at the operational level, performance indicators. These indicators provide feedback to the various levels of the organisation. In this system, performance indicators are *"of critical importance to the effective and efficient functioning of the performance management"* (Bititci et al., 1997, p. 46).

This system can be translated to a project (the right side of Figure 4-3), where, instead of a vision and business objectives, project goals are deployed via critical project success factors to performance indicators. These performance indicators give feedback of the extent to which the project goals are achieved. Therefore, in a project, performance indicators need to be somehow related to project goals in order to be relevant. This is also agreed by others (e.g. Kerzner (2011), Eckerson (2006), Haponava (2009), Neely et al. (1997)).

Time-bound

This is also one of the SMART requirements. In practice, this means an indicator should have a frequency of measuring. Neely et al. (1997) make a distinction between the frequency of measuring and the frequency of reviewing. Eckerson (2006) stresses the need for timely data, so that it is possible to improve the performance before it is too late.

Verifiable

One of the problems found by Beatham et al. (2004) regarding performance indicators in construction included a lack of verifiability (see section 4.1.4). Unclear indicators with different interpretations made it not possible to compare the indicators mutually. Neely et al. (1997) states that the source of data and the formula of calculating an indicator should be clear.

Owned by someone accountable

Collin (2002) concludes that effective performance indicators have to be owned by the organisation. This is agreed by Eckerson (2006) who says that the performance indicator has to be owned by an individual or group who is accountable for its outcome. For a further explanation how the term owned is used in this research, see the glossary in Appendix I.

Actionable

A performance indicator should trigger changes. It is the action that makes the indicators add value (Constructing Excellence, 2006). Neely et al. (1997) state that the action cannot always be specified upfront, because the action may depend on the context. However, it has to be clear upfront what management process will be followed when the performance is either acceptable or unacceptable.

Visual communication

The communication of indicators has to be clear; it has to give a quick but good view on the key processes. Collin (2002) states that graphic displays need to be simple in design, easy to update, and accessible. The graphic displays are also known as a dashboard, which *"convey the most critical information to the stakeholders the fastest way"* (Kerzner, 2011, p. 197). Using dashboards is also advised in the KPI Handbook of Constructing Excellence (2006), which advises results and trends to be displayed. Kerzner (2011) suggests the use of so-called traffic light reporting, because this can convey simply critical performance information. Traffic light reporting is shown in Figure 4-4.

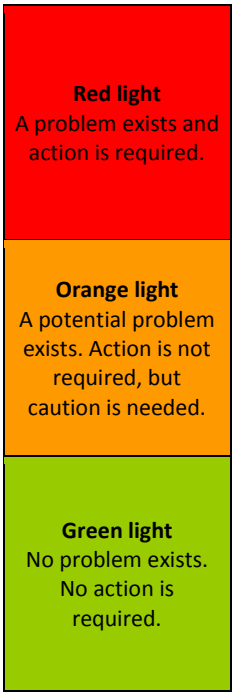

Figure 4-4: traffic light reporting

Evaluation

Identifying the indicators is done not only when starting at the start of the project, but also after a certain time period or a change of phase in a project, since the set of indicators will need to evolve and it is likely that they will change and be refined (Collin, 2002). As mentioned earlier, the fragmented nature of construction projects also insists on specific indicators tailored to each phase of the project. Moreover, evaluation at the end of the project is important to check whether the indicators contributed to the success of the project.

4.4 Conclusion

Research question 4

How are performance indicators generally used in the construction industry?

This chapter showed that the use of performance indicators in construction is partly different from their use in other industries, because of the complex, fragmented, and unique nature of construction projects. These characteristics require partly project-specific indicators that are tailored to the phase of the project. A common set used over a long-term is however possible and enables benchmarking. This chapter also revealed that there is a wide range of indicators used. It showed that other indicators than time, cost, and quality become increasingly important. Moreover, indicators have to give the opportunity to adjust; in other words, the indicators have to be a base for improvement. This also relates to the problems that are identified in current projects, such as indicators that do not give the opportunity to adjust and that are not aligned to objectives.

Best Value has an influence on the way performance indicators can be used in infrastructural construction projects. The Weekly Risk Reports, the measurements of the contractor and the focus of Best Value on risk mitigation and transparency increase the need for more project-specific indicators, although generic indicators are still of importance.

Current problems with performance indicators, together with an extensive literature review, led to a list of characteristics that should be kept in mind while developing and using performance indicators. The fourteen applicable characteristics are shown in Table 4-3.

Table 4-3: applicable characteristics derived from the literature

Characteristics
Few in number
Balanced and cover the project
Focus on improvement
Simple
Specific
Measurable
Context driven, target and bandwidth
Aligned with goals / relevant
Time-bound
Verifiable
Owned by someone accountable
Actionable
Visual communication
Evaluation

In the next chapter, the characteristics will be used in a model for the development and use of performance indicators in Best Value projects. First, a draft model will be made containing the characteristics above. This is done by distributing the characteristics over several steps. To check whether the characteristics are applicable in Best Value projects, the draft step-by-step model is evaluated by project team members of current Best Value projects. Based on their feedback, a final model is made.

5 DEVELOPMENT AND USE OF PERFORMANCE INDICATORS

This chapter describes the steps to come to solutions for the problems identified in chapter 2 and 3. Moreover, chapter 4 described the use of performance indicators is different from other construction projects: project-specific indicators play a bigger role. Therefore, partly indicators have to be developed in each project, while general construction projects can draw more from generic indicators. This chapter proposes a model for the process of this development and the use of performance indicators in Best Value projects. The model is based on the characteristics that are found in the literature, as described in chapter 4. First, a draft model is developed in section 5.1. Subsequently, this model is evaluated in section 5.2 by means of interviews with experts. Based on the feedback of the experts, the model is refined and a final model is developed. This is shown in section 5.3. The model is put into practice in two projects. A description of these tests is found in section 5.4. This chapter ends with a conclusion is section 5.5. An overview of this structure can be found in Figure 5-1.

In this chapter, research question 5 is answered by developing the draft and final step-by-step model. Research question 6 is answered by evaluating the characteristics with experts and testing the model during the clarification phase at two projects.

Research question 5

What model can be made regarding the process of developing and using performance indicators in Best Value projects?

Research question 6

Is this model applicable, relevant, and effective on Rijkswaterstaat Best Value projects?

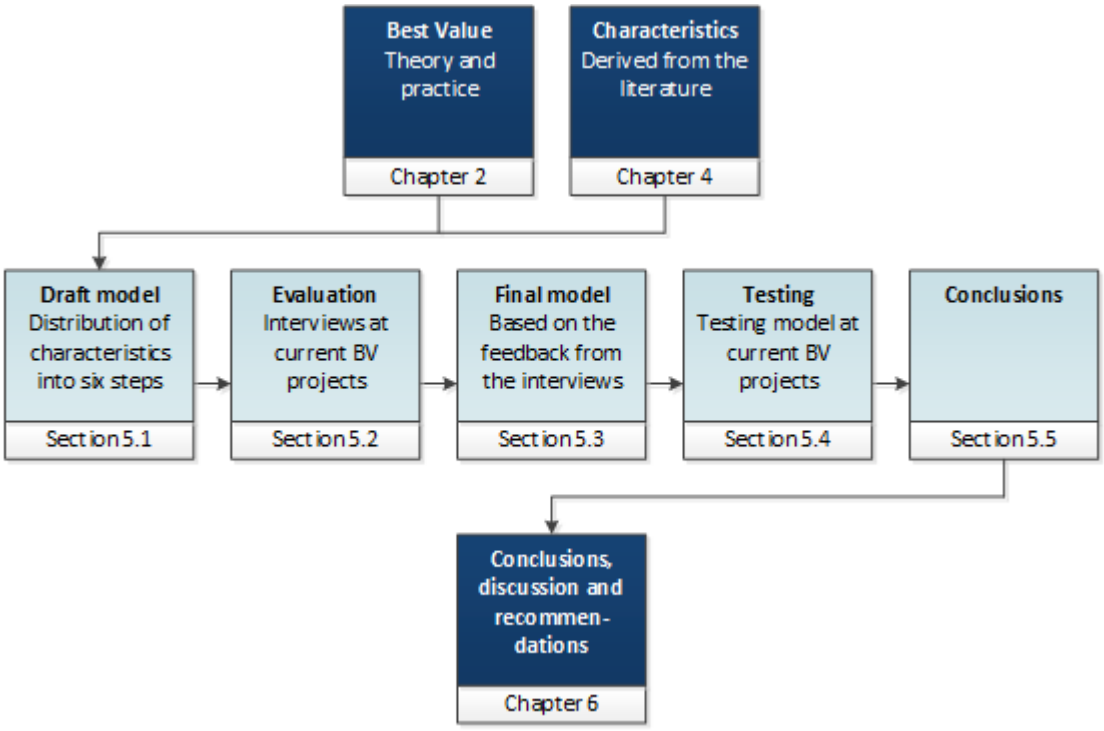

Figure 5-1: structure chapter 5

5.1 Draft step-by-step model

This section describes how the draft version of the model is developed. A more in-depth description of the development can be found in Appendix VIII.

The development of the model is based on the fourteen characteristics as found in the literature and as described in chapter 4. As described in the research goal and questions, a model that consists of several steps is chosen. Because the characteristics found are used in different phases of the process, the steps are based on where the characteristics are used in the process.

Two major phases can be distinguished: the development of indicators and the use of indicators. In between, they have to be incorporated in the Weekly Risk Report. When looking at the development, there are characteristics that deal with the total set of indicators and there are characteristics that are a requirement for each indicator. Furthermore, indicators have to be chosen based on the project goals and risks. At the end of the use of the indicators, evaluation has to take place.

This leads to six steps: *choosing the set of indicators*, *choosing the indicators*, *development of the indicators*, *incorporate in the Weekly Risk Report*, *use during the execution*, and *evaluation of the indicators*.

After that, the characteristics are distributed over these steps. Moreover, the description of the characteristics are made clearer and some characteristics are further split up. This leads to the draft model in Table 5-1.

Table 5-1: draft model

1. Choosing the set of indicators			
Few in number	Balanced	Focus on improvement	
2. Choosing the indicators			
Inside the influence area of the contractor		Outside the influence area of the contractor	
3. Development of the indicators			
Simple and specific	Purpose	Relates to	Formula
Frequency	Source of data	Client or contractor?	Target and bandwidth
4. Incorporate in the Weekly Risk Report			
Extra sheet in the Weekly Risk Report			
Progress over time	Which indicators changed	Why indicators changed	
5. Use during the execution of the project			
Action in the Weekly Risk Report			
6. Evaluation of the indicators			
Evaluate during the project		Evaluate at the end of the project	

5.2 Evaluation of the steps

The draft model, which is based on the literature of chapter 4, is evaluated in practice. This section elaborates on this evaluation.

5.2.1 Research methodology

Goal

The evaluation is done by holding interviews with experts from both the client and the contractor side. The aim is to find out what characteristics of the model are confirmed or denied by people in the field. The model is refined based upon this evaluation.

Research design

The research is conducted using individual semi-structured interviews with contract managers from both the client and contractor side. Each characteristic of the model found in Table 5-1**Fout! Verwijzingsbron niet gevonden.** is evaluated by asking the interviewee whether the characteristic is relevant for the model. The experts are the same experts as those who were asked for the problem analysis as described in section 3.1, in fact, the interviews were done at the same moment: first, the interviewees were asked about the current problems and after that, they were asked about solving the problems using the model.

The reason to let the same group of ten people do the evaluation is the limited number of Best Value projects. Six projects are analysed, but these six projects all have a very different nature and they all are in a very different phase. By splitting up these six projects in a problem analysis and an evaluation, the group that analyses the problem

and the group that evaluates the model are not comparable, which can cause an incomplete problem analysis or evaluation. Furthermore, because of the early phase of performance measuring in Best Value projects, the group that evaluates also wants to explain their problems with performance indicators, which means that this is in fact again a combination of problem analysis and evaluation.

The model is evaluated from both a client and contractor's perspective. This increases the validity of the evaluation. The interview is semi-structured; however, because of the step-by-step model, these interviews are more structured compared to the problem analysis interviews.

These interviews are also recorded and transcripts are made afterwards, in order to reduce the risk of own interpretation. The draft model is brought hardcopy to the interviews.

Analysis

The ten interviews are analysed using the 'word table' method of Yin (2009), which is a type of cross-case analysis. This method is chosen because it makes it possible to compare different cases in a uniform framework: the model as proposed in section 5.1. The word table is a matrix with a row for each characteristic and a column for each interview. The cells contain the opinion of the interviewees on a certain characteristic. The analysis of each characteristic leads to a conclusion. The word table is schematically shown in Table 5-2.

Table 5-2: word table, based on Yin (2009)

Characteristic	Interviewee 1 Case 1	…	Interviewee 10 Case 6	Conclusion
Few in number				
…				
Evaluation at end				

The word table method is a qualitative way of cross-case analysis, which relies *"strongly on argumentative interpretation"* (Yin, 2009, p. 160). However, if possible, the results will be quantified.

5.2.2 Results

Below, in Table 5-3 to Table 5-8, the results of the evaluation are shown. Each table is the word table of a certain step of the model. Only the columns *characteristic* and *conclusion* from the word table are shown, because the entire table with all the interviews is too comprehensive to show. Nevertheless, some examples of interviewee's opinions are shown with bullet points (•). In addition, the influence of the conclusion of an aspect on the final model is described. This final model is developed in the next section, section 5.3.

1. Choosing the set of indicators

Table 5-3: evaluation step 1

Characteristic	Conclusion	Influence on model
Few in number	**Agreed by all 10 interviewees.** • 3 – 10 seems fine, 5 or 6 is feasible, not more than 10. • Only the most critical indicators should be used. • Too many indicators will lose the benefit of measuring.	Because this aspect is mentioned by all interviewees, it will not be changed. Moreover, the problem analysis showed some projects had too many indicators, which increases the relevance of this characteristic.
Balanced	**Agreed by all 10 interviewees, however, extra explanation of the characteristic during the interviews was needed.** • Every project goals should be measured, in other words indicators should be connected to all aspects of the contract. • Less measurable aspects should also be measured; however, impractical measurable indicators should be avoided.	Changed into *cover all project goals*, which gives a better description of the characteristic. The characteristic will stay in the model because it is agreed by all interviewees.
Focus on improvement	**Agreed by all 10 interviewees, however, in two different ways: indicators should give an opportunity to steer and indicators should be the base for learning and development.** • It is important to be able to steer in time. • Indicators should lead to improvements, even when the indicator is below the threshold for the hundredth time: the indicator should not lose its relevance.	Moved to step 2 (*possibility to improve indicator*) and 3 (*focus on improvement*), in order to make these characteristics clearer.
Other remarks	**One interviewee mentioned that repetitive products or processes should be measured.** • Measuring a product or process that is not repetitive means that only one measurement will be done and that no improvement is possible.	Added *repetitive products/process* as characteristic in this phase. Only one interviewee mentioned this aspect, but during the research, it turned out to be an important characteristic.

2. Choosing indicators

Table 5-4: evaluation step 2

Characteristic	Conclusion	Influence on model

Inside / outside influence area contractor	**All 10 interviewees agreed that the performance of both the client and the contractor should be measured. However, other remarks or distinctions are made by the interviewees:**
	• Indicators should be connected to the project goals: the project goals are shared goals of both client and contractor.
	• Indicators should be connected to risks (which are threats to the project goals) owned by the contractor that may include a risk for the client, and risks owned by the client that can be influenced by the contractor. Risks that have no impact on the client or that cannot be influenced by the contractor are not relevant to measure.
	• Indicators may be useful in future tenders.
	• Indicators should be a mix of process and product indicators.
	• Indicators should measure both generic and specific aspects. Examples of generic indicators mentioned are:
	  ○ The average customer satisfaction score on risk mitigation measures in the Weekly Risk Report
	  ○ The percentage of received complaints that are answered in time
	  ○ Stakeholder satisfaction score
	  ○ The average Prestatiemeten[4] score
		Replaced by three new aspects, in order to make the model clearer:
		• *connect to project goals and risks*;
		• *possibly useful in future tender*;
		• *mixed indicators: client – contractor product – process, generic – project-specific*.

Other remarks	• Indicators related to the performance of the contractor can be used for the contractor's internal steering instrument. Moreover, it creates confidence to the client whether the contractor is performing as expected. • Three interviewees indicated that the client should also measure himself. • The choice of indicators is also based on the experience of the contractor in previous projects.	

[4] For more information, see the Handreiking Prestatiemeten (Dutch; Rijkswaterstaat (2012b))

3. Development of the indicators

Table 5-5: evaluation step 3

Characteristic	Conclusion	Influence on model
Title	**Agreed by all 10 interviewees, but *title* was not a clear description because extra explanation was required.** • As easy as possible. • Verifiable. • Challenging. • Attainable. • SMART. • Simple. • Base for improvement. • As effective as possible. • Relevant. • A SMART indicator with consensus about the description and use leads to objectivity and reduction of discussion. A specific indicator reduces the chance of measuring other processes than expected.	Changed the aspect into *SMART and simple*, because these aspects are most important. The other aspects mentioned by the interviewees will be part of the characteristics below.
Purpose	**Agreed by all the interviewees.** • It should be clear why the indicator has to be measured. • The goal of measuring should not be only measuring.	Although this is agreed by all interviewees, it overlaps with *connect to project goals and risks* and *minimum effort, maximum benefit*. Therefore, it is removed as a characteristic.
Relates to	**Agreed by all the interviewees. However, this aspect is mentioned several times in the model.** • Relevance is important. • Indicators should be related to risks, important processes, or project goals. • Indicators should relate to critical success factors of the project.	Removed from the model, because this is the R of *SMART*.
Formula	**One interviewee found this important; all the others found the formula not of importance. Nevertheless, they stress the importance of objectivity and transparency.** • A simple indicator does not need a formula. However, it has to be clear how is measured: this increases objectivity. • The indicator should measure purely what it has to measure: the measurement may not be influenced by other processes.	Added *verifiable* to the model. Calling this characteristic *formula* makes it too complex and is contrary to a simple indicator. However, the indicator has to be *verifiable* to create confidence for the client and to make the indicator actionable.

Frequency of measurement	**The need for a frequency is agreed by all the interviewees. However, no consensus exists about the frequency itself.** • Three interviewees said a weekly frequency (like the Weekly Risk Report) for every indicator, two interviewees said not more than a monthly frequency and five interviewees said it depends on the indicator. • One interviewee said it depends on the dynamics of the project. • One interviewee said they measure only once per four weeks. In between, they estimate the value of the indicator. • One interviewee said the frequency should be adapted to the frequency of meetings. • One interviewee said that a weekly frequency is less time-consuming than a monthly frequency, because they know exactly what happened in that week. A monthly frequency requires more research. • One interviewee stresses the concept of management by exception: by only looking what exceptions appear in the indicators, time and resources are saved.	Stayed the same.
Source of data	**Only one interviewee found this aspect important. The others stress only the importance of verifiable, objective information.** • Indicators should relate to the generated data.	Removed, because it is mentioned by only one interviewee and has overlap with *verifiable*. The source of data is of importance, but with a simple indicator, the source of data follows from the indicator and does not have to be specified again.
Client or contractor?	**Agreed by all interviewees, but this characteristic is also mentioned in other characteristics.** • The owner can also be both client and contractor.	Removed from the model, because it overlaps with *mixed indicators: client – contractor*, which is added to the model in the previous step.
Target and bandwidth	**Agreed by all interviewees.** • The target should be challenging but attainable, “running but not sprinting”. • A target and bandwidth should be developed during the clarification phase. • Both target and bandwidth is a good idea, since an indicator below the target does not directly indicate a problem. • The target and bandwidth should be based on benchmarks and experience. • The value of the indicator should also be shown, instead of only the ‘traffic light’.	Added *challenging but attainable* as a characteristic of an indicator. All interviews mentioned the need for a challenging indicator. However, it has to be attainable. Putting this characteristic in the model underlines the need to benefit the most of the indicator.

Other remarks	**All interviewees mentioned that performance indicators should not take much time, but should have a great benefit.** • Indicators should have a minimum effort, but maximum benefit. • It may not become a paper tiger, instead it should stay workable.	Added *minimum effort, maximum benefit* as a characteristic, to stress the importance of not spending too much time on measuring, which is contraproductive.

4. Incorporate in the Weekly Risk Report

Table 5-6: evaluation step 4

Characteristic	Conclusion	Influence on model
Extra sheet in the Weekly Risk Report	**8/10 interviewees agree with using the extra sheet in the Weekly Risk Report. Two interviewees communicate in their monthly progress report.** • The protection of the Excel sheet hinders the use of smart measuring of indicators related to unforeseen events in the Weekly Risk Report. • Communicating indicators in the Weekly Risk Report is good because it puts all the information in one place. • The indicators should not be hidden, instead they should be communicated clearly.	Stayed the same, because most interviews are satisfied with the extra sheet in the Weekly Risk Report.
Progress over time	**Agreed by 9/10 interviewees, but the characteristic needed further explanation.** • The trend can be shown by a – or + next to the indicator. • Conclusions can be drawn by viewing indicators over time. • A graph makes it even clearer. The progress has to be viewed in a glance. • The trend should be clearly insightful, history is important.	Changed into *show progress over time*, which is a clearer description. Showing the progress over time makes it easier to draw conclusions based on the measurements.
Which indicators changed	**Not relevant to all interviewees. Moreover, the meaning of the characteristics was unclear.**	Removed. Not needed. Overlap with *progress over time* and *why indicators changed*.
Why indicators changed	**Agreed by the interviewees, but the characteristic needed further explanation.** • It shows which situation resulted in the value of the indicator. • Indicators should be traceable; therefore, the values should not be over written.	Changed into *explanation why indicator changed*, which is a clearer description.
Other remarks	**Visual communication is mentioned by 6/10 interviewees.** • Colours and mentioning the value of the indicator is important. • It should be clear which aspects of the project need attention at a glance with a dasboard. • Visualisations are a must. Only numbers does not come through.	Added *visual communication*, because interviewees found this characteristic important. It was not put in the draft model, because it had overlap with the other characteristics. However, the interviewees stress the importance of visual communication.

5. Use during the execution of the project

Table 5-7: evaluation step 5

Characteristic	Conclusion	Influence on model
Action in the Weekly Risk Report	**All interviewees agreed action should be taken, but not every interviewee said this action should lead to an unforeseen event in the Weekly Risk Report.** • Action should be taken on indicators below the threshold. Indicators below the target do not require immediate attention. • Action can be taken with a measure to manage the indicator. • Only indicator related to risks owned by the client should be mentioned in the Weekly Risk Report. • When an indicator is constantly too low, the indicator should be evaluated. • The action should be clearly communicated to the client.	Removed the description that action in the Weekly Risk Report is required, because the interviewees are not clear to this.

6. Evaluation of the indicators

Table 5-8: evaluation step 6

Characteristic	Conclusion	Influence on model
Evaluate at the end of the project	**3 interviewees agree with this characteristic. However, 2 also mention that evaluation during the project is needed. The name of the characteristic was not clear: what is evaluated?** • Evaluation at the end is too late: there should be continuous improvement. • Evaluation: did performance indicators lead to a change of behaviour of client and contractor? • At the end of every project, the project is evaluated. The use of performance indicators should be part of this evaluation. • The evaluation should be done with client and contractor together	Changed into *evaluate indicators*, this is a clearer description.
Keep updated during the project	**All interviews agreed, but with a certain caution. Changing the indicators too much reduces transparency.** • Indicators can be changed when a new phase or new part of the project starts or when new disciplines come into the project. • Performance indicators are developed prior to the project. Therefore, it is important to evaluate them during the project. • Measuring an indicator that is no longer relevant is useless, this requires and update or removal of the indicator. • The target or bandwidth may be wrong and may require adjustments.	Moved to step 5, because the evaluation is to during the project.

5.2.3 Analysis and conclusion

Most aspects of the model, based on the literature study, are agreed and further substantiated. These aspects will be part of the final model. Interviewees found that some aspects overlap with other aspects. Therefore, these aspects are combined. The influence of the evaluation on the indicators is described in the tables above.

Some aspects, for instance *frequency*, are agreed, but the explanation is ambiguous: the one interviewee has another opinion than the other. This can be explained by the difference between the projects and the early phase of some project regarding the use of performance indicators. In the model, such ambiguities will be explained.

5.3 Final model

At the next page, in Figure 5-2, the final model is found. This model is built based on the characteristics of the draft model and the remarks made by the interviewees on these characteristics. Also, the model is made more graphical. Descriptions of the

influence on each of the characteristics of the draft model on this final model can be found in the tables in the previous chapter 5.2. The model consists of the same six steps as the draft model, because interviewees found these steps logical.

At the left side of the model, the six steps consisting of the several characteristics for the development and use of performance indicators are shown. At the right side of the model, a short explanation of each of the characteristics is given. This is done to increase the clearness of the model.

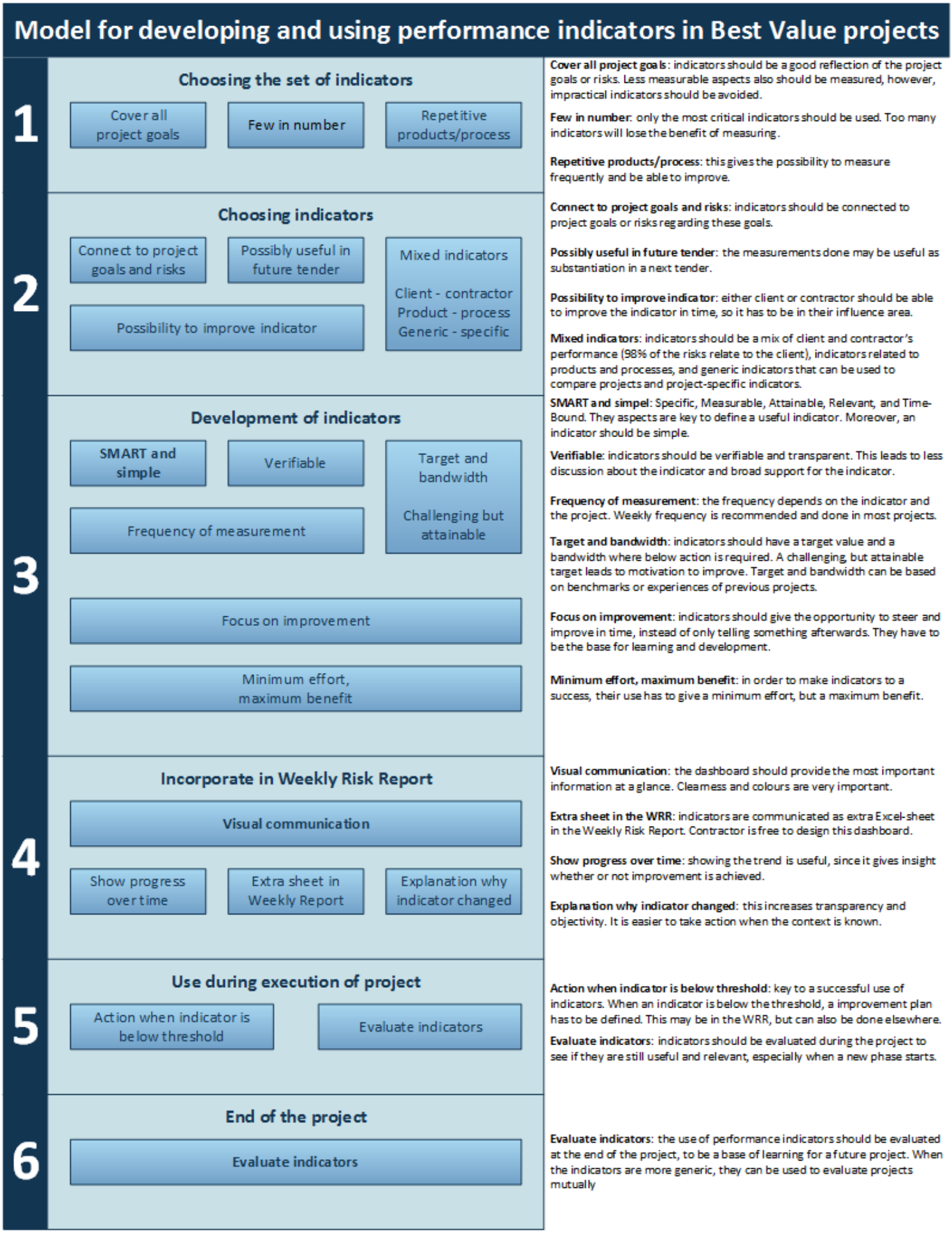

Figure 5-2: final model

5.4 Tests in practice

Confidential

5.5 Conclusion

This chapter described the four phases of building a model for the development and use of performance indicator. First, a draft model was designed. After that, the draft model was evaluated by means of interviews with experts that use performance indicators in Best Value projects at this moment. Subsequently, a final model was built. Finally, the model is tested at two Best Value projects over Rijkswaterstaat.

Research question 5

What model can be made regarding the process of developing and using performance indicators in Best Value projects?

A model is made based upon the fourteen characteristics that are found in the literature and that are regarded applicable to Best Value construction projects. In several steps, a six-step model is designed for the development and use of performance indicators. The six steps of the model include choosing the set of indicators, choosing indicators, development of the indicators, incorporate in the Weekly Risk Report, use during execution in the project, and the end of the project. The model consists of twenty characteristics in total.

Research question 6

Is this model applicable, relevant, and effective on Rijkswaterstaat Best Value projects?

All the characteristics of the step-by-step model are validated by means of interviews with experts. Most of these characteristics are agreed; characteristics that were not agreed or that had to be changed are respectively left out or improved. Moreover, several characteristics are added based on the expert input.

The model is tested in two different cases. One case included the use of the model in a session with client and contractor; the other case included the use of the model as a checklist for the performance indicators drawn by the contractor. In the first case, the model supported the session, which led to eight draft indicators complying with the characteristics of the model. Indicators with a higher compliance with the model are expected to be more useful during the execution, because the model is based on the problems with performance indicators in current projects. In the last case, it led to fifteen potential improvements for five indicators, of which thirteen were agreed and used by the contractor. This test is therefore considered as a success; however, the influence on the rest of the project is due to time limitations not researched further.

6 CONCLUSION, DISCUSSION AND RECOMMENDATIONS

In this chapter, conclusions are drawn based on the research described in the chapter before (section 6.1). This is done by answering the research questions. After that, the internal and external validity of the research are discussed (section 6.2). The chapter ends with recommendations derived from the conclusions and discussion (section 6.3). The structure of this chapter can be found in Figure 6-1.

Research question 7

What recommendations can be made to Rijkswaterstaat and what suggestions can be done for further research?

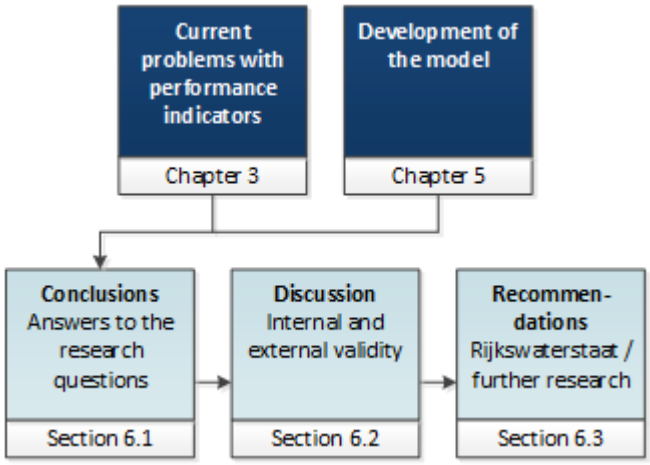

Figure 6-1: structure chapter 6

6.1 Conclusions

This section answers the research questions based on the research described in the earlier chapter. Moreover, it is verified whether the research goal is achieved.

6.1.1 Answers to the research questions

The research questions as shown in section 1.5 are answered below.

Research question 1

What is the Best Value approach?

Best Value is a procurement, project management, and risk management approach aimed at getting the highest value for the lowest price, with high customer satisfaction and high efficiency. Rijkswaterstaat uses the approach slightly different from the original, American approach, due to Dutch and European legislation. The approach exists of three phases: selection, clarification, and execution. In the first phase, a supplier is selected. After that, the prospective contractor pre-plans the project and

at the end of this phase, the project is awarded. During the execution, the focus is on risk management, each week reported in a Weekly Risk Report.

Best Value is based on the concepts of the founder of Best Value, Dean Kashiwagi. The concepts include a win-win situation for client and contractor, a high value for a low price, less management, direction, and control of the client, and giving contractors the space to show their expertise. It states that less management, direction and control of the client leads to more transparency and better risk mitigation. The theories of New Institutional Economics, such as transaction costs economics, Property rights theory and principal-agent theory, relate the advantages of the approach to the reduction of uncertainty, taking bounded rationality into account and less opportunistic behaviour.

Research question 2

What is the role of performance indicators in Best Value projects?

Performance indicators and performance information are used in every phase of the Best Value process. This is shown in Figure 6-2. At this moment, the contractor develops the indicators during the clarification phase. However, when the contractor develops indicators during the selection phase, he can show how he measures the claims made. The clarification phase can then be used to refine the indicators together with the client. This Is yet only done in a few cases at Rijkswaterstaat.

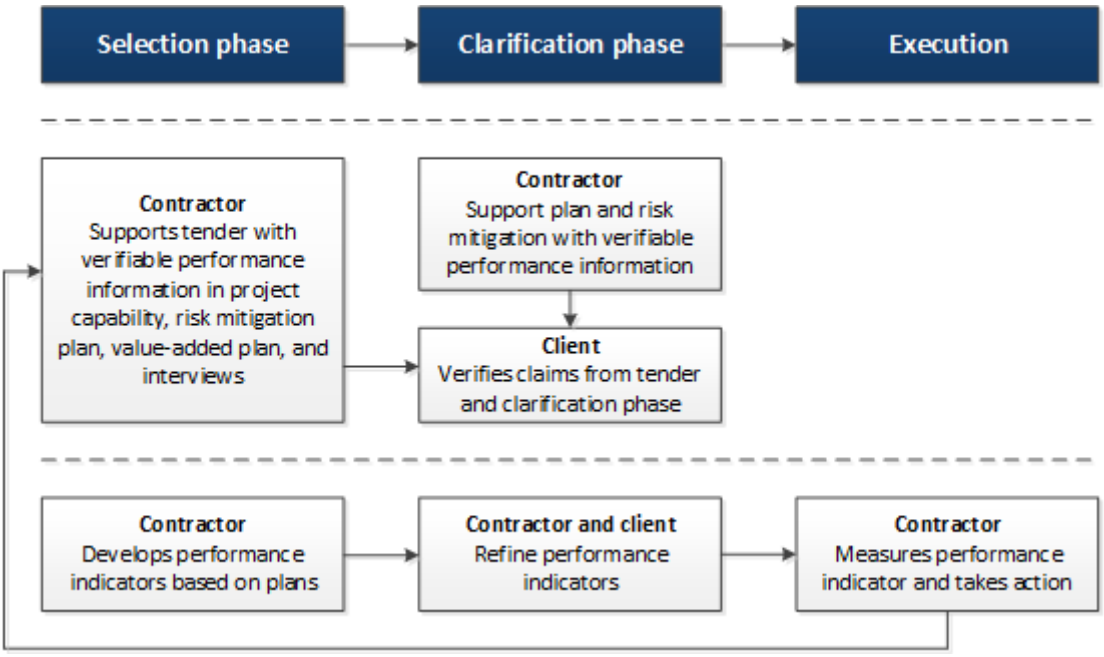

Figure 6-2: current use of performance indicators in Best Value

In Best Value, the contractor is responsible for developing the indicators, for communicating the indicators and for making action plans. Moreover, Best Value uses the Weekly Risk Report to communicate the risks and performance with a weekly frequency to the contractor. This is unique for the approach.

From the theory of Best Value, measuring performance and expressing this in an indicator creates transparency, reduces discussion and communication, and is the base for performance improvement. By creating transparency, risk is mitigated. This is agreed by seeing performance indicators from the perspective of the New Institutional Economics theory, research showed that using performance indicators leads to less uncertainty, awareness of bounded rationality, and less opportunistic behaviour of parties.

Research question 3

What problems regarding performance indicators can be identified in current Rijkswaterstaat Best Value projects?

The use of performance indicators is still in a very early phase. In each phase of the Best Value process (i.e. selection, clarification, and execution), developing and using performance indicators is found hard by both client and contractor.

The problems relate to (1) the introduction of performance indicators (contractors found it was unclear whether performance indicators should be used), (2) the awareness of both client and contractor of the goals of measuring causing a lack of motivation, (3) the lack of knowledge regarding the development and use, and (4) the availability of data and benchmarks. These problems led to a non-effective use of performance indicators during the project.

An in-depth quantitative analysis of one of the aspects mentioned in the interviews (the contractor measures only his own performance) showed that in earlier projects, most risks (98%) are owned by the client, while mostly the performance of the contractor is measured at this moment. Therefore, also the performance of the client should be measured. This also complies with the theory of Best Value, which states the contractor is the expert and it is the expert's plan that is executed. Hence, he knows the best what to measure and how to measure, even if it relates to the performance of the contractor.

Research question 4

How are performance indicators generally used in the construction industry?

The use of performance indicators in the construction industry is different from their use in other industries, because of the complexity, fragmentation, and uniqueness of a construction project. Indicators that are used for long-term benchmarking used in other industries are only partly applicable in the construction industry because of this different nature and are not used consistently.

The literature study on performance indicators in the construction industry showed a wide range of indicators and characteristics. The characteristics regarding the development and use of the indicators, which are applicable to the construction industry and Best Value context, are used in answering the next research question.

Research question 5

What model can be made regarding the process of developing and using performance indicators in Best Value projects?

A step-by-step model is made to show important characteristics for indicators in each phase of the development and use. It also pays attention to the several problems encountered by practitioners as described in the problem analysis. The model consists of six steps and twenty characteristics. The model is shown in Figure 6-3, a more detailed version can be found in Figure 5-2 in section 5.3 on page 62.

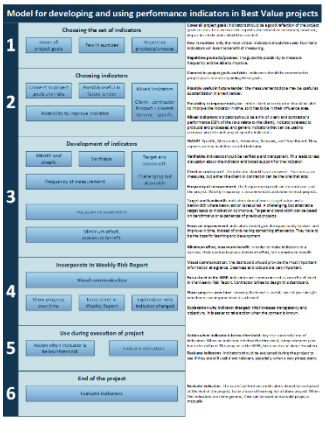

Figure 6-3: final version of the model, a more detailed version can be found in Figure 5-2

Research question 6

Is this model applicable, relevant, and effective on Rijkswaterstaat Best Value projects?

The model focuses on the development and use of performance indicators, which is one of the conclusions of the problem analysis at current Best Values projects. The draft model is validated by practitioners. The remarks of these practitioners are used for the final version of the model. Some of the characteristics of the draft model were not agreed by the interviewees, while other characteristics are added. This increases the applicability of the model. The model is also tested in two cases. In the cases, the model supported a session and it was used as a checklist. In these two cases, this led to indicators with more compliance with the characteristics of model, so in these cases the model was relevant. More compliance with the model is expected to lead to more useful indicators, because the model is based on the problems with performance indicators in the current projects. However, due to time limitations the long-term effect of the model is unknown.

6.1.2 Research goal

The research goal as described in section 1.3 says:

The objective of this research is to propose a step-by-step model for contractors and Rijkswaterstaat, for the process of developing and using performance indicators in Best Value projects.

This goal is achieved by developing, validating, and testing the model.

6.2 Discussion

This section discusses the internal and external validity of this research. The decisions made during the design of this research as well as decisions made while executing the research imposed several limitations. Most of these limitations are related to the early stage of performance indicators in Best Value projects, which means a lack of quantitative data exists.

Internal validity

The data analysis is only conducted on the Spoedaanpak projects, because these projects are mostly finished and therefore suitable for research. Whereas these D&C projects were all part of one programme concerning the widening and better utilisation of the highway, the conclusions may not be applicable to other projects, such as engineering services or water engineering projects. However, it is expected that also in such other projects, the part of the risks owned by the client is large, because the client owned about 98% of the risks in the researched case. Furthermore, the Spoedaanpak projects were executed mainly between 2009 and 2011. However, because of the early phase Best Value is in, the evolvement of the approach since then, and therefore the different impact on the projects, the risk profile may be different. Nevertheless, it is expected that the client owns even more risks, because one of the principles of the approach is seeing the contractor as an expert that has no risks.

Another limitation is number of interviewees. This number is too low to draw general conclusions based on quantified information. In addition, the same group of interviews is used for the problem analysis and validation. Although the character of these two interview rounds is different, it may have decreased the strength of the validation. A more quantitative analysis is needed to draw stronger conclusions.

The interviews were done at six current Best Value projects. Although this number of projects is high compared to other clients, it is still not enough to draw profound conclusions. The projects are chosen because of their diversity, but this also led to only one or two project per type. More research has to be done on other projects, also from other clients to see whether all problems with performance indicators in Best Value are covered with this research.

A major concern of the interviewees turned out to be the overlap with other processes of Rijkswaterstaat. Since this aspect lies not in the scope of this research, further research at Rijkswaterstaat has to be done to map the overlap and seek for improvements.

From the Best Value theory, the contractor has to measure and this is assumed the best way to use indicators in this research. However, the client can also measure, as well as other parties: maybe everyone in the supply chain has to measure instead of only the contractor. More research on who measures is needed.

The model developed in this research is only tested on a small scale in one meeting. Therefore, further research on more projects required. In addition, the embedment and content of a session with client and contractor regarding performance indicators during the clarification has to be further researched, because this was out of the scope of this research. Because the clarification phase seems to have a major influence on the rest of the project, more research on the course of this phase is needed.

Finally, the influence of indicators developed and used with the model on the success of projects is unknown, because a long-term research on performance indicators in a project was not possible due to the limited time available for this research. Therefore, extra research is needed to investigate the influence of performance indicators on the success of a Best Value project.

External validity

This research is conducted at the Best Value core team of Rijkswaterstaat. Because of the success of earlier Best Value projects and the possibility to apply Best Value on a relatively large number of projects, Rijkswaterstaat is one of the most advanced clients worldwide regarding Best Value. This increases the external validity of this research. However, this research did only focus on projects in the civil engineering sector, instead of other sectors at Rijkswaterstaat. In addition, only projects of Rijkswaterstaat are analysed. Further research is therefore required to find out whether the model and the recommendations of this research are applicable in other projects outside Rijkswaterstaat.

6.3 Recommendations to Rijkswaterstaat

This section describes the recommendations to Rijkswaterstaat, based on the conclusions in section 6.1 and discussion in section 6.2. This section answers research question 7 and is split up between recommendations to Rijkswaterstaat and suggestions for further research.

Research question 7

What recommendations can be made to Rijkswaterstaat and what suggestions can be done for further research?

6.3.1 Recommendations to Rijkswaterstaat

The goal of performance measurements and the benefits of using performance indicators should be explained better and more practical to both market parties and the project teams of Rijkswaterstaat.

In order to create intrinsic motivation of the market parties and the project teams, the goal of performance measurements and the benefits of the use of performance measurements should be explained more during trainings, not only theoretical, but also practical: in what way can it contribute to a successful project? Examples from other projects can be used to make the explanation even more practical. More intrinsic motivation of market parties and the project teams of Rijkswaterstaat will lead to a better development of the indicators in the clarification phase, or when the contractor already proposed indicators in the selection a better refinement of the indicators, and useful use of the indicators during the execution of the project. Explanation can be given by the Best Value core team in general meetings and prior to a project. However, the most important moment is during the clarification phase, when the project team of Rijkswaterstaat and the prospective contractor should agree on the indicators and their use.

More attention has to be paid to performance indicators during the clarification phase. Ensure that the indicators are supported by the project team of client

and contractor. Use the model to support a session for performance indicators and to check whether the characteristics of performance indicators are present.

As stated in the previous recommendations, the clarification phase is the most important phase. In this phase, the project team of Rijkswaterstaat and the prospective contractor develop and agree on performance indicators. The phase has a strong effect the use of performance indicators during the execution. Therefore, useful indicators should be developed, if not already developed by the contractor in the selection phase, and both the project team and the prospective contractor should support these indicators. In order to create this support, a 'performance indicators' meeting should be hold during the clarification phase with both the project team of the client and the prospective contractor. In this meeting, they can develop together the indicators, after which the prospective contractor can further work out the indicators. The model as proposed in this research can be used to support this session as well as checking the developed indicators afterwards.

More focus has to be put on performance indicators during the execution of the project. Ensure that action is taken at client and contractor when an indicator is below the threshold.

A performance indicator is useless if no action is taken upon an indicator below the threshold. It should be clear when the contractor should take action, what action in general should be taken and how this is communicated. Taking action is also part of the model as proposed in this research. Literature suggested putting incentives on indicators, but also warned to do this only on stable indicators. With a focus on project-specific indicators, more unstable indicators, this seems less applicable.

Consider prescribing some generic indicators.

The interviews showed a lack of benchmarks and therefore it is hard to establish target for indicators. Generic indicators, such as average customer satisfaction score or stakeholder satisfaction score, can be used over projects, although each construction project is to a certain extent unique. This makes it possible for both client and contractor to compare projects mutually and to learn and improve; due to the inconsistency of indicators at this moment, this is not possible. Already some generic indicators are used in the Weekly Risk Report, such as deviation of time and budget. However, this is not used to compare projects. Generic indicators can be part of the Director's Report: due to the inconsistency of the indicators, they are not part of the Director's Report at this moment.

Evaluate the use and the impact of performance indicators at Best Value projects. Evaluate during the project, but also at the end.

Evaluation should be done during the project, because the indicators developed prior to the execution may become less relevant during the actual execution of the project. However, caution should be taken when changing indicators, because it may make measurements less useable. Performance indicators should also be part of the evaluation at the end of the project, in order to see what effect the indicators had and how the use can be improved in future projects.

Involve market parties in the use, the evolvement, and evaluation of performance indicators at Best Value projects.

The collaboration with market parties increases the support for using performance indicators and hence the benefits of it. Because in Best Value, contractors are responsible for the measurements, it is especially important to involve market parties.

6.3.2 Recommendations for further research

Research on the course of the clarification phase

The Best Value theory states the clarification phase is the most important phase. This research showed this also applies to the use of performance indicators. A 'performance indicator' session with the project teams of both client and the prospective contractor is suggested, but another way of paying attention of performance indicators in the clarification phase may exist.

Research on who should measure

The Best Value theory states the contractor should measure, because it is his plan that is executed and hence he knows the best what to measure, how to measure and how to take action. However, the client can also measure aspects in his influence area and subcontractors can also measure. More research is needed to verify whether the contractor should measure and communicate the indicators or also the others in the supply chain.

Research on the overlap with other processes at Rijkswaterstaat

Contractors found the use of performance indicators in Best Value projects has overlap with other processes at Rijkswaterstaat, such as System-based contract management and Prestatiemeten. In addition, overlap exists with the Weekly Risk Report, for example risks can be tracked in both performance indicators and the Weekly Risk Report or client satisfaction can be measured with performance indicators, while the Weekly Risk Report also measures client satisfaction on risk mitigation measures. More research is needed to see what processes overlap and whether and how this should be avoided.

Research on the effect of performance indicators on the success Rijkswaterstaat's Best Value projects

Best Value, and especially the use of performance indicators in Best Value projects, is in an early phase in general and so at Rijkswaterstaat. The success of using performance indicators and measurements done by the contractor is not yet quantified. Theory states that it leads to transparency and thus risk mitigation, reduces discussion and communication, performance improvements, less uncertainty, taking bounded rationality into account, and less opportunistic behaviour. More research is needed to give insight into the effect on these aspects and on the effect of performance indicators on Best Value project success.

7 REFERENCES

Anderssson Elffers Felix. (2012). *Innovatieve marktbenadering*. Utrecht.

Ang, G. K. I. (2011). Historical Overview of Best Value in the Netherlands. *Journal for the Advancement of Performance Information & Value*, *3*(1), 6–11.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria. *International Journal of Project Management*, *17*(6), 337–342.

Beatham, S., Anumba, C., & Thorpe, T. (2004). KPIs: a critical appraisal of their use in construction. *Benchmarking: An International Journal*, *11*(1), 93–117.

Behn, R. D. (2003). Why Measure Performance? Different Purposes Require Different Measures. *Public Administration Review*, *63*(5), 586–606.

Bititci, U. S., Carrie, A. S., & McDevitt, L. (1997). Integrated performance measurement systems: an audit and development guide. *The TQM Magazine*, *9*(1), 46–53.

CCI. (2010). CCI Performance Suite. Retrieved April 24, 2013, from http://www.kpiengine.com

Chan, A. P. C., & Chan, A. P. L. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal*, *11*(2), 203–221.

Collin, J. (2002). *Measuring the success of building projects – improved project delivery initiatives*.

Constructing Excellence. (2006). *2006 UK Construction Industry KPIs Handbook*. London: Constructing Excellence.

Cox, R. F., Issa, R. A., & Ahrens, D. (2003). Management's Perception of Key Performance Indicators for Construction. *Journal of Construction Engineering and Management*, *129*(2), 142–151.

Deloitte The Netherlands. (2012). Dutch Sourcing Awards.

Dorée, A. G. (2004). Collusion in the Dutch construction industry: an industrial organization perspective. *Building Research & Information*, *32*(2).

Duren, van, J. (2013, June). *De waarde van PiPS voor de Nederlandse Bouwsector verklaard* (Dissertation). University of Twente, Enschede.

Eckerson, W. W. (2006). *Performance Dashboards: Measuring, Monitoring and Managing Your Business*. Hoboken, New Jersey: John Wiley & Sons.

Egan, J. (1998). *Rethinking Construction: Report of the Construction Task Force*. London: HMSO.

Eisenhardt, K. M. (1989). Agency Theory: An Assessment and Review. *The Academy of Management Review*, *14*(1), 57–74.

Ghalayini, A. M., & Noble, J. S. (1996). The changing basis of performance measurement. *International Journal of Operations & Production Management*, *16*(8), 63–80.

Grossman, S. J., & Hart, O. D. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy*, *94*(4), 691–719.

Haponava, T. (2009). *Process performance for control of project goals in construction* (Dissertation). University of Twente, Enschede.

Haponava, T., & Al-Jibouri, S. (2009). Identifying key performance indicators for use in control of pre-project stage process in construction. *International Journal of Productivity and Performance Management*, *58*(2), 160–173.

Hevner, A. R. (2007). A Three Cycle View of Design Science Research. *Scandinavian Journal of Information Systems*, *19*(2), 87–92.

Hevner, A. R., March, S. T., & Park, J. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105.

Kagioglou, M., Cooper, R., & Aouad, G. (2001). Performance management in construction: a conceptual framework. *Construction Management and Economics*, *19*, 85–95.

Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard - measures that drive performance. *Harvard Business Review*, (January-February), 71–79.

Kashiwagi, D. T. (2011). Case Study: Best Value Procurement/Performance Information Procurement System Development. *Journal for the Advancement of Performance Information & Value*, *3*(1).

Kashiwagi, D. T. (2012). *The Best Value Approach: A Supply Chain Approach*.

Kashiwagi, D. T. (2013a). *2013 Best Value Standard*. Mesa, Arizona: Kashiwagi Solution Model.

Kashiwagi, D. T. (2013b). *2013 Information Measurement Theory*. Mesa, Arizona: Kashiwagi Solution Model.

Kashiwagi, D. T., & Byfield, R. E. (2002). Selecting the best contractor to get performance: On time, on budget, meeting quality expectations. *Journal of Facilities Management*, *1*(2), 103–116.

Kashiwagi, D. T., Kashiwagi, J. S., Kashiwagi, A., & Sullivan, K. (2012). The Research Model that Revolutionized the Dutch Construction Industry. *Journal for the Advancement of Performance Information & Value*, *4*(2), 133–146.

Kashiwagi, D. T., & Parmar, D. (2004). Past Performance Information in the Construction Industry. Presented at the ASC International Proceedings of the 40th Annual Conference.

Kashiwagi, J. S. (2013). *Factors of success in Performance Information Procurement System / Performance Information Risk Management System* (Dissertation). TU Delft, Delft.

Kerzner, H. (2011). *Project management metrics, KPIs, and dashboards: a guide to measuring and monitoring project performance* (1st ed.). Hoboken, New Jersey: John Wiley & Sons.

Moore, G. (1991). *Crossing the Chasm: marketing and selling technology products to mainstream consumers*. Harper Business.

Neely, A. (1998). Three models of measurement: theory and practice. *International Journal of Business Performance Measurement*, *1*(1), 47–64.

Neely, A. (1999). The performance measurement revolution: why now and what next? *International Journal of Operations & Production Management*, *19*(2), 205–228.

Neely, A., Richards, H., Mills, J., Platts, K., & Bourne, M. (1997). Designing performance measures: a structured approach. *International Journal of Operations & Production Management*, *17*(11), 1131–1152.

Rijkswaterstaat. (2011a). *Ondernemingsplan 2015: eén Rijkswaterstaat, elke dag beter!* The Hague: Rijkswaterstaat.

Rijkswaterstaat. (2011b). *Annual Review 2012*. The Hague: Rijkswaterstaat.

Rijkswaterstaat. (2011c). *Spoedaanpak Wegen: De resultaten per 31 mei 2011*.

Rijkswaterstaat. (2012a). *Luchtfotoserie omlegging Zuid-Willemsvaart Veghel-Den Bosch ID432474*. Retrieved from https://beeldbank.rws.nl/MediaObject/Details/432474

Rijkswaterstaat. (2012b). *Handreiking prestatiemeten Rijkswaterstaat*.

Rijkswaterstaat. (n.d.-a). Aanleg 3e kolk Beatrixsluis en verbreding Lekkanaal. Retrieved May 7, 2013, from http://www.rijkswaterstaat.nl/water/plannen_en_projecten/vaarwegen/lekkanaal/aanleg_3e_kolk_beatrixsluis_en_verbreding_lekkanaal/index.aspx

Rijkswaterstaat. (n.d.-b). Zuid-Willemsvaart: opwaarderen tussen Den Dungen - Veghel. Retrieved May 7, 2013, from http://www.rijkswaterstaat.nl/water/plannen_en_projecten/vaarwegen/zuid_willemsvaart/opwaardering_omlegging_zuidwillemsvaart/opwaarderen_zuid_willemsvaart_den_dungen_veghel/index.aspx

Rijkswaterstaat. (n.d.-c). A9: omlegging bij Badhoevedorp. Retrieved June 21, 2013, from http://www.rws.nl/wegen/plannen_en_projecten/a_wegen/a9/omlegging_bij_badhoevedorp/

Rijkswaterstaat Staf DG. (2013, February 15). Verslag van Bestuur RWS, Internal memo.

Rijt, van de, J., & Santema, S. (2012). The Best Value Approach in the Netherlands: A Reflection on Past, Present and Future. *Journal for the Advancement of Performance Information & Value*, *4*(2), 147–160.

Rijt, van de, J., & Santema, S. (2013). *Prestatieinkoop* (3rd ed.). Driebergen: Scenter.

Rijt, van de, J., Witteveen, W., Vis, C., & Santema, S. (2011). Best Value at the Directorate-General for Public Works and Water Management in The Netherlands: A Case Study of the Procurement of Infrastructure Projects Worth $1,200M. *Journal for the Advancement of Performance Information & Value*, *3*(1), 90–100.

Toor, S.-R., & Ogunlana, S. O. (2010). Beyond the “iron triangle”: Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *International Journal of Project Management*, *28*(3), 228–236.

Van Duren, J., & Dorée, A. G. (2008). An evaluation of performance information procurement system (PIPS). Presented at the Third International Public Procurement Conference (IPPC), Amsterdam.

VARA. (2001, November 9). ZEMBLA: sjoemelen met miljoenen. Hilversum: VARA.

Vrijhoef, R. (2011, November 25). *Supply chain integration in the building industry: The emergence of integrated and repetitive strategies in a fragmented and project-driven industry* (Dissertation). Delft University of Technology, Delft.

Williamson, O. E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. *Journal of Law and Economics*, *22*(2), 233–261.

Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed.). Thousand Oaks, CA: SAGE.

Yuan, J., Zeng, A. Y., Skibniewski, M. J., & Li, Q. (2009). Selection of performance objectives and key performance indicators in public-private partnership projects to achieve value for money. *Construction Management and Economics*, *27*(3), 253–270.