Evaluating the relevance of NEC3 contracts on the collaboration between stakeholders in the Dutch building industry

NEC3

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English summary

The uniqueness of every building project ensures that different contract forms and different collaborations are needed. The uncertain and complex nature of these projects requires an effective stakeholder & risk management approach to accommodate conflicting interests (Mok et al., 2014). Conflicts arise in the development of construction projects due to perceptions and expectations of the different stakeholders involved (Mok et al., 2014). In Great Britain the New Engineering Contract (NEC) is a ruling contract for many years now. Adjustments in the family of NEC have been made over the past years, which resulted in a third edition in 2005: The NEC3 contract. NEC3 is known for its unique, collaborative and cooperative approach and encourages supply chain integration. Not every professional in the building industry is convinced of the contract (FE LONDON, 2010), but supporters perceive the contract as an effective project management tool. Important project management tools of the NEC3 contract relate to risk management and stakeholder management: the contract stimulates trust and collaboration between the contractor and the client. The target contract within NEC3 ensures that the stakeholders will search for cost efficient solutions in the design and the execution of the works and risk management is perceived to be a collective task. This research elaborates on risk and stakeholder management literature, uses a case study and a maturity model and finally a SEM analysis (statistical method) and together they will serve to get a good understanding of the positive and negative aspects of NEC3.

Risk management
The large scale of NEC3 projects ensure that there is a high need for good problem solving procedures. NEC3 attaches great importance to the management of construction risks (early warning system and compensation events) and the management of stakeholders (open book system, mutual trust). A comparison with the common used risk management tools is needed to better understand the innovative aspects NEC3 brings into the Dutch building industry. Reviewing several articles on the common used risk management tools in the last decade showed that checklist and knowledge/learning based approaches were the most used tools to handle problems or risks in a building project. NEC3 makes use of a risk register: this risk register is established collaboratively and revised and altered during the project. The literature on risk management showed indeed that risk registers are already used in the current construction industry (however, not established collaboratively). Just as that NEC3 classifies the risk on their importance, the most of the reviewed literature classified the risk on the basis of low and high importance or internal and external. These risk management concepts all relate to the **planning and control** of the project. NEC3 attaches great importance to the process and the effective planning of the building project that satisfies all stakeholders.

Stakeholder management
Next to risk management, NEC3 has included many aspects concerning stakeholder management. One of those aspects is clause 10.1 concerning **Trust**. There are a lot of factors that result in trust between the stakeholders in a project. To better understand the effectiveness of this NEC3 clause, literature on the trust development factors in the universal construction industry in the past decade are reviewed to be able to see the trust clause of NEC3 in perspective. Job performance, open communication and clear role expectations are factors that encourages trust between the different stakeholders. Cheung et al. (2011) developed a comprehensive trust classification system; he describes that all factors that lead to trust can be divided into three categories namely system-based trust (trust in the system

of the project), cognition-based trust (based on knowledge) and affect-based trust (based on feelings). Because NEC3 attaches great importance to the trust clause, this system is used in the research model of this research. Another stakeholder management tool of NEC3 is 'sound project management', which means that the project team should encourage a **sound business**. When a business is sound, the policies and liabilities are clear and there is close collaboration. When all the clauses of the contract are followed, the **quality of the performance** can be guaranteed by following the joint objectives and the risk programs. Not to forget that the tender quality is the starting point of a qualitative collaboration.

When the procedures of the contract are strictly followed, the chance of project success increases. The four most important factors Planning & Control (PC), Trust (T), Sound Business (SBW) and Quality Performance (QP) (the bold factors mentioned above) which all represent several clauses of the contract play a role in the success of a NEC3 project (OSN) and will be used in the analysis of this research.

Case study
To test if the British contract could be implemented in the Dutch construction industry, three Dutch experts with knowledge of the contract were interviewed to validate the information on NEC3. These three experts all have a relationship to the only available Dutch NEC3 project, the International Criminal Court in The Hague. Meng et al. (2011) developed a maturity model to measure the relationship level between a client and a contractor. An adjusted version of this model that measures the trust level between the two stakeholders is a supporting tool for the case study on ICC. The case study is tested by means of seven criteria in the maturity model namely; trust during procurement, objectives, collaboration, communication, problem solving, risk allocation and continuous improvement. The trust level within ICC was measured with the help of the expert and resulted in a score of 3.3. This means that the trust within the ICC project was strong. This assessment of the project was executed to better understand the positive and negative items of the contract.

Structural Equation Modelling
This research uses factor analysis within Structural Equation Modelling (SEM) analysis to assess unobservable 'latent' factors. This sounds difficult, but it means that the analysis is seeking for concepts/factors that best represents the NEC3 contract (the goal is to find out if these are indeed the factors mentioned above; PC, T, SBW, QP & OSN. SEM is a family of statistical methods and this research employs SEM because this method is commonly justified in social sciences: the assessment of Trust is important and SEM has the ability to impute relations between the five factors and important clauses in NEC3 (Schumacker & Lomax, 2010). In the case of this research these factors are extracted from the chapters on risk and stakeholder management. To be able to test the importance of these factors in achieving project success, ±120 Dutch experts in the construction industry (with or without knowledge of the contract) were asked to value 19 items/clauses of the contract that together present these five factors (the three expert of the case study also filled in the questionnaire). When conducting the SEM analysis in the statistical tool SPSS AMOS, the results show that important innovative concepts of the NEC3 contract such as the early warning system and the risk allocation policy are valued quite high. However, the innovative concept of an open book system is valued relatively low. When looking at the five latent factors, Trust, Soundness of

Business and Quality Performance have a strong relation to the project success of NEC3. However, Planning & Control had a negative correlation with the project success. A reason for this negative relation must be found in the dataset obtained by the completed questionnaires: sample size was not optimal and the questioning was sometimes ambiguous.

Dutch summary

Omdat ieder bouwproject uniek is, wordt de behoefte naar verschillende contractvormen en verschillende samenwerkingsverbanden steeds groter. De onzekere en complexe aard van bouwprojecten vereist een effectief stakeholder- en risico management om tegenstrijdige belangen tegen te gaan (Mok et al., 2014). Conflicten die ontstaan bij de ontwikkeling van een bouwproject zijn te wijten aan de verschillende percepties en verwachtingen van de verschillende belanghebbenden (Mok et al., 2014). In Groot-Brittannië voert het New Engineering Contract (NEC) al voor vele jaren de Engelse bouw industrie aan. Door de jaren heen zijn er veel aanpassingen gedaan aan dit contract, wat resulteerde in de derde editie in 2005: NEC3. NEC3 staat bekend om zijn unieke en coöperatieve aanpak en stimuleert ketenintegratie en echt samenwerken tussen opdrachtgever en opdrachtnemer. FE Londen (2010) concludeert dat niet elke professional in de bouwwereld overtuigd is van het contract (vooral juristen niet) maar de aanhangers zien het contract als een effectieve project management tool. Belangrijke project management tools van het NEC3 contract hebben betrekking op risico- en stakeholdermanagement; het contract gaat uit van vertrouwen in elkaar en samenwerking tussen de opdrachtgever en opdrachtnemer. Het target contract binnen de NEC3 familie zorgt ervoor dat de stakeholders gezamenlijk naar kostenefficiënte oplossingen in het ontwerp en tijdens de uitvoering zullen zoeken. Daarbij wordt risicomanagement gezien als een collectieve taak. Dit onderzoek maakt gebruik van risico en stakeholder management, een case studie, een maturity model en een SEM analyse (statistische methode) om samen een goed beeld te krijgen van de positieve en negatieve aspecten van het NEC3 contract.

Risico management
De omvang van bouwprojecten zorgt ervoor dat er een grote behoefte is aan goede probleemoplossende procedures. NEC3 hecht veel waarde aan het beheer van risico's (door een systeem in te voeren waarbij de stakeholders verplicht zijn om vroegtijdige waarschuwingen te geven en door de invoering van compensation events) en het beheer van de stakeholders (open boek systeem, wederzijds vertrouwen). Een vergelijking met de gangbare risico management tools is nodig om de innovatieve aspecten die NEC3 kan brengen in de Nederlandse bouwwereld beter te begrijpen. Het bestuderen van een aantal artikelen over de gangbare risico management tools in de laatste tien jaar heeft laten zien dat checklists en op kennis gebaseerde benaderingen de meest gebruikte instrumenten zijn om problemen of risico's in een bouwproject te beheersen. NEC3 maakt gebruik van een risico register: dit risico register wordt door de stakeholder gezamenlijk vastgesteld, herzien en gewijzigd tijdens het project. De literatuur over risico management toonde inderdaad dat risico registers ook al worden gebruikt in de huidige bouw (echter worden deze registers niet gezamenlijk vastgesteld). Net zoals dat NEC3 de risico's classificeert op hun belang, beoordelen de meeste artikelen de risico's ook op basis van lage & hoge urgentie of intern & extern. Risico management concepten hebben allemaal betrekking op de **planning en het proces(controle)**

van het project. NEC3 hecht groot belang aan het proces van het bouwproject en aan een effectieve planning, waarbij alle stakeholders tevreden zijn.

Stakeholder management
Naast risico management heeft NEC3 vele aspecten met betrekking tot stakeholder management opgenomen. Een van die aspecten is clausule 10.1 die gaat over wederzijds **vertrouwen**. Er zijn velen factoren die resulteren in vertrouwen tussen de betrokken partijen in een project. De effectiviteit van deze NEC3 clausule kan getest worden aan de hand van literatuur over 'factoren die leiden tot vertrouwen in de bouwsector' om zo de clausule in perspectief te plaatsen. De genoemde literatuur betreft hier internationale artikelen van de afgelopen tien jaar. Werkprestaties, open communicatie en duidelijke taakverdeling zijn factoren die vertrouwen tussen stakeholders vergroot. Cheung et al. (2011) ontwikkelde een uitgebreid vertrouwen classificatiesysteem: ze beschrijven dat alle factoren die leiden tot vertrouwen kunnen worden onderverdeeld in drie categorieën, namelijk vertrouwen in het systeem van het project, vertrouwen op basis van kennis en vertrouwen op basis van gevoelens. Omdat NEC3 heel veel waarde hecht aan clausule 10.1, wordt dit classificatie systeem gebruikt in het researchmodel van dit onderzoek. Een ander kenmerk van NEC3 is 'sound project management', wat betekent dat het projectteam een **gezonde bedrijfsvoering** moet aanmoedigen. Het zorgt voor een duidelijk beleid, verplichtingen en nauwe samenwerking. Wanneer alle bepalingen van het contract worden gevolgd, kan de **kwaliteit van de prestaties** worden gegarandeerd door het volgen van de gezamenlijke doelstellingen. Niet te vergeten dat de kwaliteit van de aanbesteding het startpunt is van een kwalitatieve samenwerking.
Wanneer de procedures van de overeenkomst in acht genomen worden, wordt de kans op succes vergroot. De vier belangrijkste factoren Planning & Controle (PC), Vertrouwen (T), Gezonde Bedrijfsvoering (SBW) en Kwaliteit van de Prestaties (QP) (de dikgedrukte factoren) die allemaal bepaalde clausules bevatten van het contract spelen allemaal een rol in het succes van een NEC3 project (OSN) en worden gebruikt in de verdere SEM analyse.

Case studie
Om te testen of het NEC3 contract in Nederland geïmplementeerd kan worden, zijn drie experts met kennis van het contract geïnterviewd om de informatie te valideren. De drie experts hebben allemaal een relatie met het enige NEC3 project op Nederlandse bodem namelijk de bouw van het nieuwe Internationale Gerechtshof in Den Haag (ICC). Meng et al. (2011) hebben een maturity model ontwikkeld die het relatieniveau tussen een opdrachtnemer en een opdrachtgever meet. Een aangepaste versie van dit model dat het vertrouwen niveau tussen de twee partijen meet is een ondersteunende tool voor de case studie over ICC. De case studie wordt getoetst aan de hand van zeven criteria in de maturity model namelijk; vertrouwen tijdens de aanbesteding, de gezamenlijke doelstellingen, samenwerking, communicatie, probleemoplossend vermogen, risico verdeling en continue verbetering van processen. Het vertrouwen niveau binnen ICC werd gemeten met behulp van de experts en resulteerde in een score van 3,3. Dit betekent dat het vertrouwen binnen het ICC project sterk was. De assessment van de case studie door middel van het maturity model werd uitgevoerd om beter inzicht te krijgen in de positieve en negatieve aspecten van het contract.

Structural Equation Modelling

Dit onderzoek maakt gebruik van Factor Analyse binnen de statistische methode 'Structural Equation Modelling' (SEM) om factoren te kunnen beoordelen. Dit klinkt ingewikkeld, maar het betekent dat de analyse op zoek is naar concepten/factoren die het beste het NEC3 contract representeren (het doel is om inderdaad de vijf factoren PC, T, SBW, QP en OSN te abstraheren van de analyse). Dit onderzoek maakt gebruikt van SEM omdat deze methode wordt gerechtvaardigd in de sociale wetenschappen: het beoordelen van vertrouwen speelt in dit onderzoek een grote rol en SEM heeft de mogelijkheid om de relaties van de vijf factoren met de NEC3 clausules te meten (Schumacker en Lomax, 2010). In het geval van dit onderzoek zijn de vijf factoren die werden geëxtraheerd uit de hoofdstukken over risico- en stakeholder management: Trust, de Gezonde Bedrijfsvoering, Planning & Control, Kwaliteit van de Prestatie en het algehele succes van een NEC3 project. Om in staat te zijn het belang van deze factoren in relatie tot het succes van een NEC3 project te kunnen beoordelen, zijn Nederlandse experts in de bouwsector (met of zonder kennis van het contract) gevraagd om een questionnaire in te vullen waarin de waarde van 19 items (die gelijk staan aan clausules), die samen de vijf factoren representeren moeten worden beoordeeld. Deze ±120 experts zijn van verschillende constructiebedrijven die verkregen zijn door warm contact van HEVO bv. De drie experts van de case studie hebben ook de questionnaire ingevuld. De SEM analyse wordt uitgevoerd in het statistische programma SPSS AMOS. De resultaten laten zien dat belangrijke innovatieve concepten van het NEC3 contract, zoals het 'early warning' systeem en de risicoverdeling hoog gewaardeerd worden. Echter, het innovatieve concept van een open boek systeem wordt relatief laag gewaardeerd. Dit heeft te maken met het feit dat de Nederlandse bouwwereld zich conservatief opstelt met betrekking tot veranderingen. Wanneer gekeken wordt naar de vijf factoren, Trust, de Gezonde Bedrijfsvoering, Planning & Controle en de Kwaliteit van de Prestatie hebben een sterke relatie met het succes van een NEC3 project. Echter, Planning & Control had een negatieve correlatie met het succes van een NEC3 project. Een reden voor dit negatief verband moet worden gezocht in de dataset verkregen door de ingevulde questionnaires: steekproef was niet optimaal en de vraagstelling was soms onduidelijk.

Evaluating the relevance of NEC3 contracts on the collaboration between stakeholders in the Dutch building industry

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Abstract

The development and planning of complex sustainable building projects and the implementation is a multiscale task and especially because of the participation of multiple stakeholders across multiple disciplines (Thabrew & Ries, 2009). The uncertain nature of complex building projects require an effective risk and stakeholder management approach to align conflicting stakeholder interests (Mok, Qiping, & Yang, 2014).
A practical tool to manage these large construction projects could be the New Engineering Contract 3 (NEC3). This collaboration is a family of contracts, which offers a complete end-to-end project management for the entire project life-cycle; from planning, all risks defining legal relations of the stakeholders and the procurement of work (NEC3 contracts, 2014).

The thesis consists of a literature review on NEC3, risk management (RM) & stakeholder management (SM) and a research model that analyses the perceived success factors of NEC3 according to Dutch building experts. The review discusses the importance of the management of stakeholder interaction in complex construction projects with a focus on trust (supported by a trust maturity model), soundness, performance of a team and risk management with the focus on common used risk management tools in the building industry and planning & control. The innovative management concepts of the NEC3 will be elaborated to understand the possible contribution of this contract to the Netherlands. The research model analyses the risk and stakeholder management tools of the contract.

While clients want to make the best decision in selecting the most suitable contractor and subcontractors for the project, a clear understanding of the underlying clauses associated with the project's contract in the context of achieving successful project outcomes is critical (Doloi, 2011, p. 687). To understand the clauses in the NEC3 contract and the links to the five concepts extracted from the literature review Trust, Soundness of Business, Planning & Control, Quality Performance and Project Success, a structural model is created. The research model uses Structural Equation Modelling because this method's interest usually focuses on factors as abstract psychological variables like trust and is able to test different hypotheses about the five important aspects of this research and tries to understand the links of these aspects with different clauses in the NEC3 contract. This thesis collected data across construction companies in the Netherlands and the structural model confirmed that the innovative concepts in the NEC3 contract are highly evaluated by the experts. However, the relation between the Planning & Control and the Overall Success of a NEC3 project was not acknowledged. The understanding of the significance of the clauses in the context of the success of NEC3 according to Dutch experts contributes to enhancing the knowledge and the notoriety of the contract: understanding the added value and the contribution of NEC3 in the field of risk & stakeholder management when looking at the overall project success.

Keywords: NEC3, clauses, Trust, Planning & Control, Sound project management, Quality Performance, maturity model, Structural Equation Modelling

1 Introduction

1.1 Problem definition

The uncertain and complex nature of construction projects requires an effective stakeholder management (further called as SM) & risk management (further called as RM) to accommodate conflicting interests (Mok et al., 2014). Conflicts arise in the development of construction projects due to perceptions and expectations of the different stakeholders involved (Mok et al., 2014). Complex sustainable projects are massive investments, which have long schedule, extreme complexity and social impacts. These projects are more complex because the construction industry in the Netherlands is extremely conservative, and subject to slow rates of change due to liability, regulatory and limited technology transfer from other sectors of society (Yang & Zou, 2014, p. 209). These complex projects are almost not feasible with traditional contracts. The shortcoming of these standard contracts is that they have encouraged contradicted behaviour. The stakeholders tend to be motivated to act in their own interests rather than to achieve the project objectives (Wright & Fergusson, 2009). The goal of this research is to investigate the impact of SM and good RM on the overall success of NEC3 building projects. This British NEC3 contract is claimed to be designed in such a way that literally everything is laid down in the agreement between parties and that the principal of an 'open book system' is leading in information sharing. Especially the gain/pain mechanism is seen as a positive aspect in achieving common interests. However, the question is whether or not these stories are emblazoned and whether the successful implementation is country-specific. In this contract everything revolves around good RM and SM, so that is the reason why these two concepts are included in this research.

1.2 Research question(s)

This study examines the contributions of certain NEC3 clauses from a successful project delivery perspective. Previous studies of Hatush and Skitmore (1997) and Doloi (2009) already examined the selection criteria of a contractor to enhance the project success and this research uses elements of these articles to examine the criteria of the NEC3 contract to enhance the project success. In fact, NEC3 attaches great importance to the procurement of the project and thus selecting the right contractor for the job. These articles identified factor associated with the selection that were used in a confirmatory analysis. In continuation of these scientific articles, this thesis will develop a model that highlights the relational links between the NEC3 clauses (associated with Rm and SM) and the overall project success): Structural Equation Modelling (further called SEM). This research tries to get a better understanding of the added value of NEC3 for the Dutch construction industry.
In order to investigate these links the following main research question is formulated:

How does NEC3 improve the interaction between multiple stakeholders and the problem solving procedure in complex building projects?

In order to give an answer to the main question, the following sub questions are formulated:

Sub research questions:
      1) What are NEC3 contracts?
      2) The advantages of NEC3 in comparison with other contracts;

3) Setting up good RM in complex construction projects;
4) The development & the role of trust between different stakeholders in complex
   construction projects as the source for success factors;

The first four research questions are leading in the search for literature on NEC3, RM and SM. The literature review will answer these first questions.
The research model serves to answer the remaining two research questions and eventually the main question:

5) What are the success factors of NEC3 in the Netherlands given the success factors
   in the UK?
6) What are the perceived advantages of NEC3 in the interrelationship between RM
   and SM components?

1.3 Research design

This thesis is a contribution to the knowledge of the NEC3 contract for the Dutch construction industry in the field of RM and SM. Some companies like Brink Groep and Royal Haskoning have tried to implement the new contract in the Dutch environment, but the developments do not run easily. The objective of this research is providing for concise information on the contract, because the current available information is enormous and organized in different English books and to convince the Dutch people that, despite of the burden that the information is in English, the contract is very easy to understand and encourages collaboration and transparency.

In order to conduct the research within the preferable duration of six months, limitations should be set:

❖ The focus is on the benefits and downsides of the NEC3 contract in the Dutch
   environment, so only a case study in the Dutch construction industry will be used;
❖ The NEC3 is a family of contracts: for each form of project there are different contracts
   that could be applied. This research focuses on the construction of buildings (not infra
   or services) and the most common used contract NEC3 Engineering and Construction
   Contract option C (Target contract);
❖ NEC3 is a contract with hundreds of clauses. For this research the clauses that relate
   to RM and SM are examined;
❖ Because the contract is of international origin, international concepts of RM and SM
   are investigated. Because these concepts are very complex and extensive, only
   concepts relevant in relation to the contract will be examined.

On the next page, figure 1.1 presents the research design, which is constructed to answer the research questions. The design starts with the problem exploration in the state of the art literature. When the problem is stated, the research will begin with the review and then the data collection. The model will consist of a case study, factor analysis and SEM.
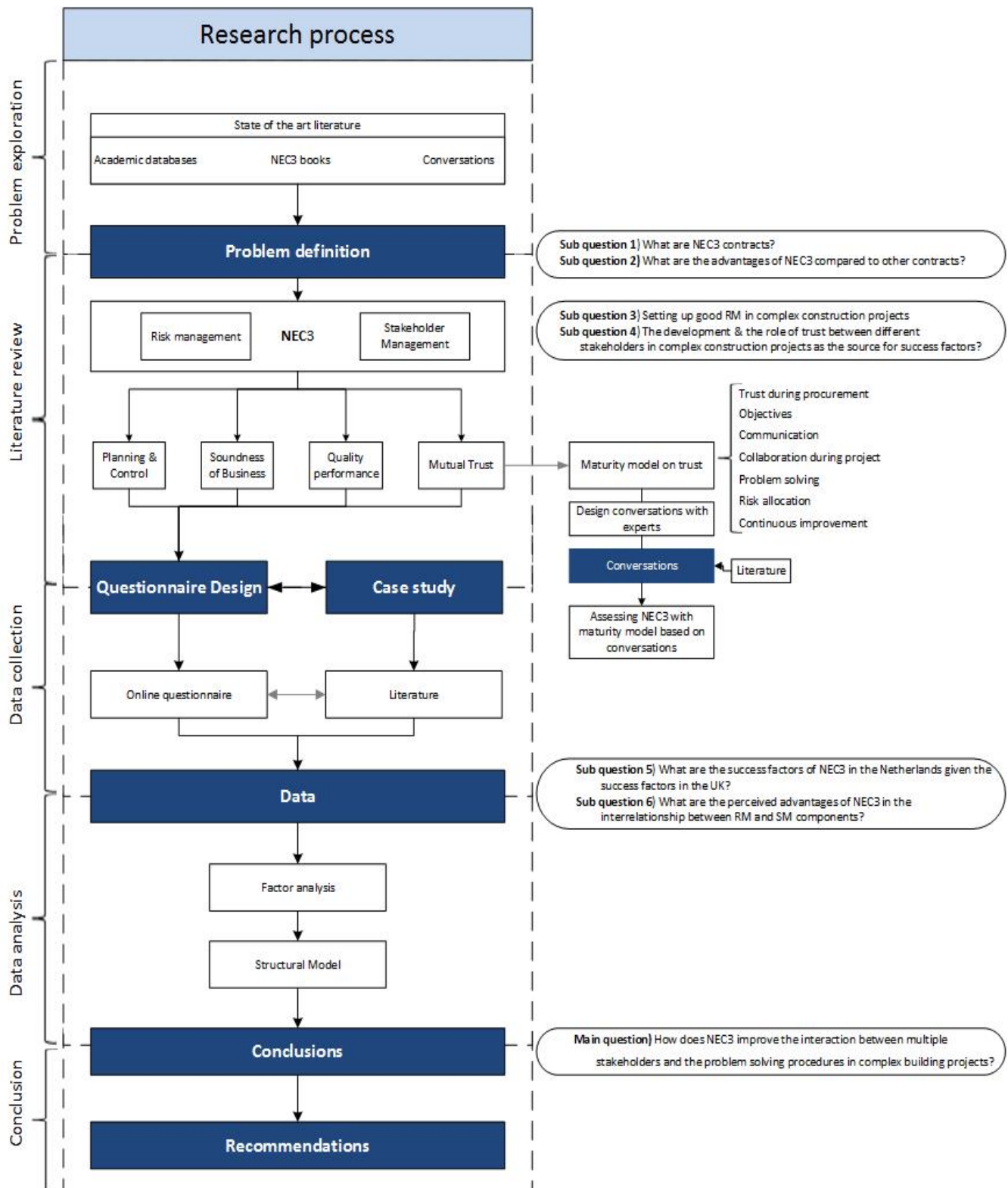
Figure 1.1 Research design

1.4 Expected results

The goal of this research is to gain knowledge on the British NEC3 contract. Dutch construction workers are shivery in accepting new collaboration and concepts what is the reason that this research should contribute to the development of awareness of the benefits and the downsides of the contract. The results will consist of two elements: at first assumptions on the NEC3 contract will be validated by means of a case study (supported by a maturity model) and conversations with three experts (who have experience with the contract). The second part will be the SEM analysis which validates the importance or unimportance of certain NEC3 clauses in the field of risk and SM. It is expected that the results of the case study and the SEM analysis are in some way contradictive, because the Dutch project in the case study was very successful and guided by a British project director: the successfulness of this project could be a coincidence. The results of the SEM analysis will support or reject the positive stories on the contract, because the dataset only consists of Dutch respondents.
It is also expected that despite of cultural differences, the risk and SM tools of NEC3 will also work in the Netherlands (early warning system, compensation events) when the procedures are strictly followed.

1.5 Reading guide

This thesis is subdivided into four different parts. Chapter 2 Glossery is a list of the most important definitions of this research. It will elaborate on the principles of NEC3, RM, SM and the used method in this thesis structural equation modeling. Chapter 3 Literature review will elaborate on the existing (foreign) literature on NEC3, the common used risk and SM tools in the past years and perceived project success factors. This chapter will be closed with a discussion on the findings and a conclusion which provides for future research ideas. Chapter 4 will be about the validation of the contract by introducing a case study of the contract applied in the Netherlands. The contract will be assessed against a maturity model on trust, since trust is an important aspect of NEC3 according to existing literature. A second part of chapter 4 will be the construction of a structural model on the perceived success factors of a project management by the NEC3 contract. In this way the several clauses in the direction of risk and SM tools are examined. Chapter 4 will be closed by the results of the analysis and the discussion. Recommendations on the contract and the perceived added value for the Dutch building industry will be given. Finally the overall conclusion of the thesis will be given in chapter 5 Conclusion. This chapter is subdivided in the conclusions of the case study and the conclusion of the structural equation modeling analysis.

It is assumed that certain readers are interested in specific parts of this research. If the reader is searching for specific information on the contract, chapter 3.4, paragraph 4.3.3 and paragraph 5.1.1 (as a conclusion of the case study) are important sections to explore.
The setup of this thesis is that the literature review and the research model are separate scientific articles which can be explored individually. But at the same time chapter 4 is a successor of chapter 3. Another important remark is that the research talks about the relations between the factors. Correlation, relation, loading, coefficient estimate, weights are all the same designations for the relations between the factors. And also the difference between the definition of 'factor' and 'items' (attributes) should be taken into account.

2 Glossery

Activity schedule	A list of the activities which the Contractor expects to carry out in completing his obligations under the contract
Bill of Quantity (BOQ)	A document used in the construction industry for tendering, in which materials, labor, parts and their costs are itemized. It also details the conditions and terms of the construction contract and itemizes all work to enable a contractor to price the work for which he is bidding
Confirmatory factor analysis (CFA)	**Factor analysis**: identify a relatively small number of individual factors which can be used to represent the relationships among sets of many interrelated variables (to get a small set of variables (uncorrelated) from a large set of variables (most of which are correlated)) **CFA**: an analysis to test whether data fits a hypothesized measurement model. CFA evaluates a priori hypotheses and is largely driven by theory. The numbers of factors are hypothesized in advance, whether or not these factors are correlated and which items load onto and reflect which factors
Defined costs	Amounts owed to subcontractors for work which was subcontracted plus the costs of components in the schedule of cost components for work not subcontracted
Integrated contracts	A contract wherein different phases (design and execution of work) are carried out by one contractor
IPM	Integrated Project Management. HEVO is known for its unique Integrated Project Management. With this particular form of service HEVO act as a partner of the client (delegated commissioning). HEVO works for and with the client and want to take over the concerns and risks of the client. The risks allocation will vary in each project that fits the client and the project the most
Measurement model	The measurement model is the part of structural equation modeling that examines relationships between the latent variables and their attributes/items
Network	An extended group of people with similar concerns or interest who interact and remain in informal contact for mutual assistance or support.
RM (RM)	The process of identifying and assessing risks, and to apply methods to reduce those risks to an acceptable extent (Tohidi, 2011).

	HEVO: The identification and quantification of risks and the establishment of preventive control measures to reduce the probability of occurrence or to influence the consequences of risks (HEVO, 2014). To cover both definitions, the following paraphrase is given: Adopting measures to identify risks, to analyze and respond to these risks, in order to reach the desired effect on the company or project objective'.
Planning & Control	The chance of project failure becomes higher when the submitted planning/program is incomplete or not realistic (Ahmad, Younis, Ahmad, & Anwar, 2015). A detailed planning and the control of this planning would enhance success and reduce risks. When a contractor submits a program that is not practicable a project manager should withhold acceptance for this reason to control the overall project (Eggleston, 2015). The project manager is responsible for the project planning and the quality and must understand the stakeholder's needs.
Procurement	The act of buying work, services or goods from an external source. In this research construction projects.
Project management (PM)	Organizing, planning, motivating and controlling resources to achieve specific goals and meet specific success criteria. During a project the temporary multi organization applies knowledge, skills, tools, and techniques to project activities to meet the project requirements.
Soundness of Business & Workforce (SBW)	According to Ahmad, Younis, Ahmad, & Anwar (2015, p. 817) an established organization can produce better results. The soundness of business includes reputation and consistency of an organization. When a TMO of many companies with multiple expertise work closely together with an open book system, the likelihood that team members work according to a common interest becomes higher.
Stakeholder	Individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion (Project Management Institute, 2001). Who can affect or is affected by the achievement of the firm's objectives.
SM(SM)	The process of monitoring & maintaining constructive relationships between stakeholders, by appropriate management of their expectations and agreed objectives. This process must be planned by underlying principles.

Structural Equation Modelling (SEM)	A family of statistical methods designed to test a theoretical or conceptual model. Structural equation models try to assess unobservable 'latent' concepts (factors). The term refers to two things: a **measurement model** defines latent variables using one or more observed variables and a **structural regression model** links latent variables together. The links between factors of a structural equation model may be estimated through involved approaches such as those employed in AMOS.
	
	    Unobservable latent concepts in this research relate to Trust, Soundness of Business, Planning & Control, Quality Performance and Overall Success of NEC3 project.
	    Observed variables relate to the different clauses mentioned in the NEC3 contract. In scientific articles these observed variables are also called 'items'. So 'clause' equals 'items' and 'observed variable'.

Structural model	The relationship between the latent variables.
Temporary multi organization (TMO)	A group of people responsible for complex tasks over a limited period (project-based) and are typically cross-functional, consisting of members who have complementary skills and come from separate, fragmented but interdependent companies who share pre-defined goals and schedules. In the thesis TMO is also associated with project team. Projects relate to temporary establishments, with a defined beginning and end time and a defined scope.
Time risk allowance	Also called free float in the programme: the allowed duration in each activity by the Contractor to account for the risk in not completing that activity in the minimum possible period. It owned by the Contractor and cannot be used to mitigate the effect of a compensation event (Evans, 2013)
Trust	It expresses the belief that the stakeholders' decisions will be beneficial for all parties which will allow to limit the inspections. The organization on whom the involved stakeholders depend will meet the positive expectations rather than the fears (Gad & Schane, 2014; Radziszewska & Szewczyk, 2014)
UAV	Uniform Administrative Conditions for the Netherlands for the execution of works and technical installations in 2012 (a sequel of UAV 1989). These conditions can be declared applicable in a contract. Specifications and agreements are more uniform when applying the UAV.

UAV-GC	Uniform Administrative Conditions for Integrated Contracts.
Work done to date	Defined costs which the project manager forecasts will have been paid by the contractor before the next assessment date
	Price for work done to date: the amount that is owed to the contractor for each group of completed activities without defect which would delay following work.
Quality performance (QP)	A weak planning can affect the quality of a project. Quality is the satisfaction measurement criteria for every part of project deliverables. The satisfaction and trust that stakeholders have are critical factors for project success (Ahmad et al., 2015; Doloi, Iyer, & Sawhney, 2011). The quality of the performance of a project is in some cases perceived as a more important factor than time.

3 Literature review

3.1 Abstract

The uncertain nature of complex building projects requires an effective risk and SM approach to align conflicting stakeholder interests (Mok et al., 2014). Conflicts arise in the development of construction projects due to perceptions and expectations of the different stakeholders involved (Mok et al., 2014). A lot of research had been conducted to map the different interests of stakeholders in projects and the risks allocation procedure. Yang and Zou (2014, p. 208) stated that the majority of prior research is limited to the use of linear impact when evaluating the impact of risks or stakeholders on sustainable building development without consideration of the associated risks and stakeholders, and the interrelationship between risks and stakeholders. This review will discuss the importance of the management of stakeholder interaction in complex construction projects with a focus on trust, soundness and performance of a team and RM (with the focus on common used RM tools in the building industry and planning & control) and the innovative management concepts of the New Engineering Contract edition 3. In this review the added value of NEC3, a family of contracts that facilitates the implementation of sound project management and defines all risks carried by each stakeholder in a collaboration will be elaborated (NEC, 2014).

Keywords: NEC3, RM, planning & control, SM mutual trust, maturity model, sound business, quality performance

3.2 Introduction

The main research question is formulated as follows:

How does NEC3 improve the interaction between multiple stakeholders and the problem solving procedure in complex building projects?

To be able to answer this question involving a few subjects, a literature study will be carried out. This study is an attempt to fill the gap of research in the field of the interrelationship between stakeholder and RM in the Western culture. The New Engineering Contract edition 3 will be examined, to provide a better understanding and useful insights to construction practitioners for mitigating risks and disputes in interest in management strategies.

Many articles focus primarily on one of the two aspects, either SM in large construction projects (Eskerod & Huemann, 2013; Missonier & Loufrani-Fedida, 2014; Yan et al., 2014), or RM and mitigation (Guo, Chang-Richards, Wilkinson, & Li, 2014; Rafindadi, Mikić, Kovačić, & Cekić, 2014; Serpella et al., 2014). Yang & Zou (2014) searched for ways to combine these two aspects by assuming that SM is interrelated with the risks. This research will expand the knowledge of the interrelationship between risks and stakeholders, by introducing a familiar collaboration in the UK, China & New Zealand called the New Engineering Contract. This collaboration will encourage all parties in a construction project to perform in the concept of 'best value for money', trust & partnership. Because this way of working is not common in the Dutch Construction Industry, this research could contribute to a new perception on RM and stakeholder relations in complex construction projects.

3.3 Criteria to search literature

This review was undertaken by an intensive comparison of journals of the RM, SM and NEC3 domain in complex construction projects with temporary multi-organizations (TMP). **Four search criteria** were established for paper retrieval. At first, the International Journal of Project Management was the leading project journal and was selected to capture the European trends in generic project management research (as establishment of RM and SM). The academic databases Scopus, ScienceDirect, Emerald Insight and ABI/INFORM were used for publications. The second research criteria was to use core concepts, including SM, RM, complex construction projects, trust factors and NEC3. These concepts are divided into units through research sub questions.

Thirdly, the scope of search was scaled to a time spam of 1993-2015. This timeframe is selected, because the NEC contract appeared in 1993 (Gould, 2007; Watermeyer, 2015) and because the advantages of the NEC contract will be examined, only literature of construction projects later than 1993 could be examined. For further research, only a case study after 2005 will be picked as example. In that year the third edition of NEC was introduced. The case study will be used to get a better understanding of the positive and negative aspects of the NEC3 contract. More than 90 publications that conducted studies in trust, risk and SM in construction were identified in this period. Researchers like Gad & Schane (2014) argue that there is still a need to systematically introduce trust into project management and recommended further research to determine how construction contracts can be drafted to best reflect the trust perception between stakeholders or to compare trust levels in different project delivery methods. In this research the NEC3 contract will be introduced to see how the interrelation between stakeholder trust and risks can be improved. A limitation to this aspect is that intra-organizational trust will be eliminated. This trust aspect means that individuals within the organization trust the organization to which both individuals are part of (Gad & Schane, 2014). In this research the inter-organizational trust is central. The choice was made to search for articles that examined the trust between stakeholders in multi organizations. Papers addressing risks with no connection to the management of stakeholders in an organization are excluded.

Fourthly, literature with conclusions on the Eastern sampled enterprises will be considered carefully, with respect for culture differences. There is an interdependence between culture and the nature of working relationships (Suprapto, Bakker, Mooi, & Moree, 2014).

3.3.1 Literature review setup

In order to have a good start with the literature review, a flow diagram is presented to structure and order a complex system and to reveal the underlying structure of the elements and their interaction in this review. Because everything will be linked to the New Engineering Contract 3 the starting point will be an extensive research into the important items of the family of NEC3 contract with the focus on the Engineering and Construction Contract (ECC). A comparison with other integrated contracts and the NEC-ECC is a parallel step of this extensive research. The part of NEC3 contains RM and SM principles. Research into these project management areas is conducted to understand these areas. Principles of good RM, classification of risks, trust models, trust development factors and maturity model will be 'extern' NEC3 search terms for the review on RM and SM(matrices are constructed to understand how RM and SM with a special focus on trust is handled in the construction industry). Compensation events, the risk register and mutual trust shape the outcomes of the NEC3 RM and SM concepts. Five factors namely planning and control, soundness of business, mutual trust and quality of performance and overall success of a NEC3 project derived from the literature will be linked to the criteria of the maturity model and together form the basis for further research. These factors (compared to the relationship criteria of the maturity model) are the basis of good RM and SM and shape the performance of a NEC3 project.
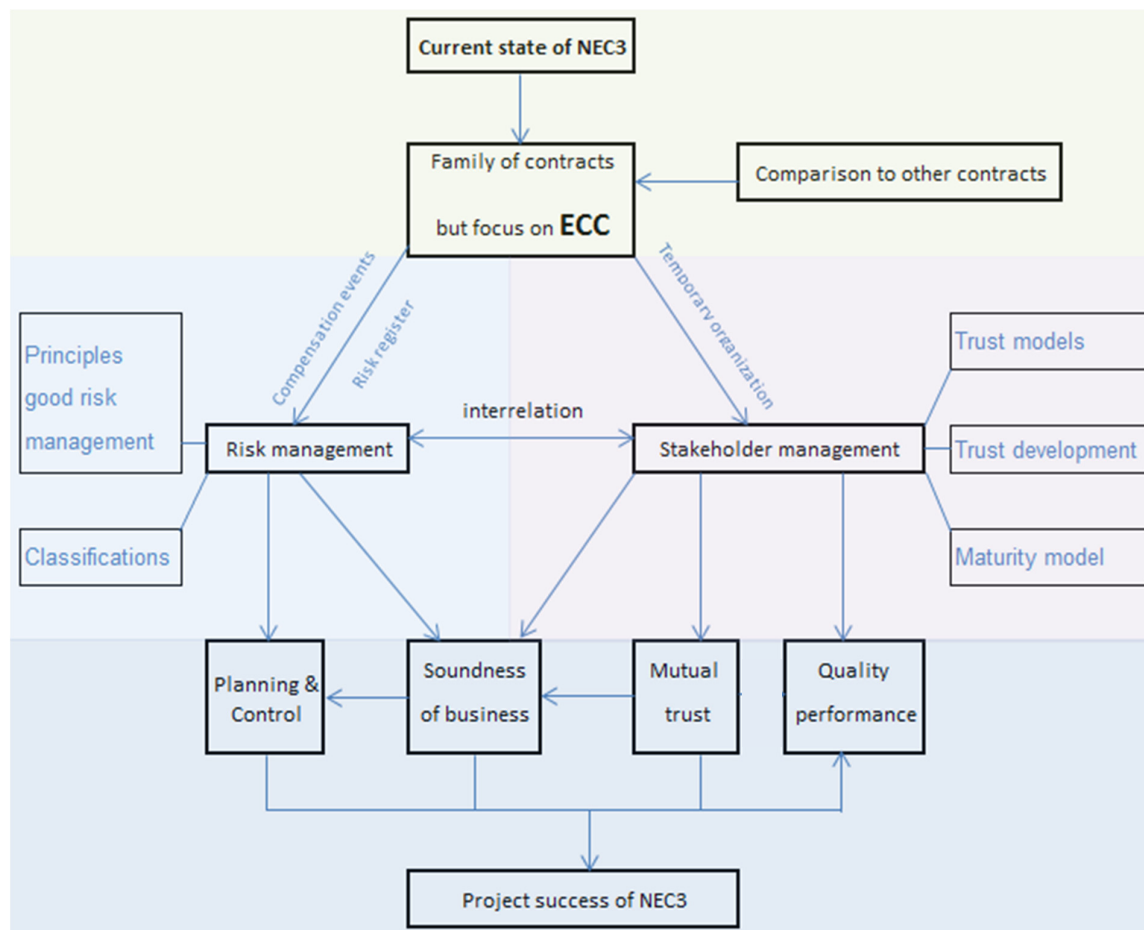
Figure 3.1 Flow diagram literature review

3.4 Current state of the New Engineering Contract 3

Companies seeking to build an industrial facility or for example a healthcare facility can document their agreement with the contractor through a construction contract. These contract specify coordination with architects and subcontractors, the scope of the work, project completion schedules and bid analysis. Suprapto et al. (2014) defines a gap in the research area of contract types influencing project-specific contexts (p. 679). One of the key options for procurement in the British engineering works in the public sector is The New Engineering Contract. The awareness of the contract is distributed internationally, especially South Africa, Great Britain, New Zealand, Australia and Hong Kong. However, the Dutch society is in the process of exploring. This section is trying to shed light on the phenomenon of NEC3 and the advantages this collaboration could bring into the Dutch building industry. Also the applicability of this collaboration in the Dutch 'way of thinking' (economical and juridical) is taken into account.

The first edition of the NEC contract was published in 1993 (NEC, 2014). This contract included building and engineering contracts. The second edition appeared two years later, called the NEC Engineering and Construction Contract with a additional contract called the Professional Services contract (used for the appointment of a contractor to provide professional services). The third edition of NEC was introduced in 2005, has an extension in the clauses but has the same goal:

'*NEC3 is a family of contracts, producing a diverse range of definitive end-to-end project management contracts that empower users to deliver projects on time, on budget and to the highest standards*'.

It is called a family of contracts, because the NEC3 suit has a specific contract for every contractual relationship. The Engineering and Construction Contract in NEC3 remains the main contracts for the construction of buildings. NEC3 came also with additional contracts, namely a Term Service Contract (appointing a contractor for a period of time to manage and provide a service) and a Supply Contract (used for the international and regional procurement and supply of high-value goods and associated services (i.e. transformers or turbine rotors) together with related services like design).

NEC3 is written in plain language instead of legal language with no references. The contract consists of basic agreements, core clauses on which specific choices are made regarding the project. The possibility exists to define additional clauses. NEC3 is focused on good management of both the client and the contractor side. Early meetings for discussing possibilities and opportunities is a must. Introducing something by one stakeholder must trigger a respond by the other stakeholder within a certain time. Failing to respond automatically means accepting what is inserted. The projects is continuously at a high level in this way.
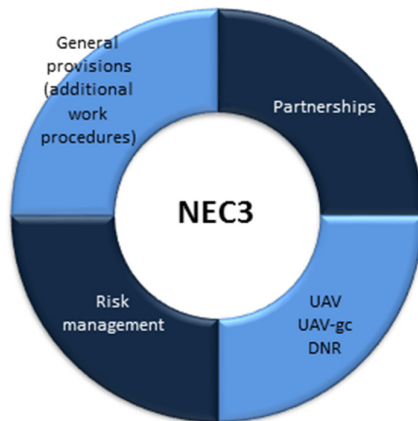
Figure 3.2 NEC3 coordinated system (Brink Groep, 2013**)**

Three core principles involved in the NEC3 are flexibility, simplicity and clarity (Gould, 2007). NEC3 offers a specific contract for every contractual relationship within the building process (Brink Groep, 2013a), based on the philosophy of collaboration, transparency, 'early warning' and trust. The latter is discussed in part 3.6 Stakeholder management (SM). NEC3 combines the separate arrangements in the Netherlands together in one system; combining the UAV-GC, general provisions such as additional work procedures, partnerships and RM (Figure 3.2).

3.4.1 NEC3 as an agreement system for different contract forms

Just as the UAV-GC is applicable to all integrated contracts such as Design & Build collaborations, the NEC3 contract is applicable to many contract forms between client and contractor as explained in the previous section. This could be for 'Services' (In the Dutch construction Industry the DNR is applied), for 'Design & Build' collaborations or traditional collaborations (UAV/UAV-GC), 'Long-term maintenance and facility services' (no specific regulation in the Netherlands) and 'Supply' contracts (no regulation in the Netherlands).

Table 3.1
Contract forms in the Netherlands vs NEC3

Contract form	Current state Netherlands	NEC3 contract
Services	Project manager, architect: DNR	Professional Services Contract (PSC)
Design & Build	UAV or UAV-GC	Engineering & Construction Contract (ECC)
Long-term maintenance Facility services	No specific regulation in the Dutch construction industry*	Term Services Contract (TSC)
Supply contract	No specific regulation in the Dutch construction industry	Supply Contract (SC)

*It should be noted that the Public Private Patnership (in Dutch PPS contract) of the Rijksoverheid is a combination of Design & Build contracts and **maintenance** contracts. The Rijksoverheid uses PPP contracts for governance buildings and infrastructure (D&B) but also for maintenance projects.

The NEC3 contracts in the right column of table 3.1 present the contractual relationship. To make it even more complex, these contract have also short contracts or subcontracts (for the use of contracts which do not require sophisticated management techniques and impose low risks). For example, the ECC contract has also a short version called the Engineering and Construction Short Contract (ECSC) and a subcontract called the Engineering and Construction Subcontract (ECS). These contract vary in risks carried by both the client and contractor. This complexity will be made clear in section 'Summarizing contracts of NEC3'.

The main construction contract in the NEC3 family, the ECC, is equivalent to the current Design & Build of the UAV-GC and extracted nine core clauses which show the main purposes of the collaboration within the NEC3 contract. These core clauses are 'general', time, payment, compensation events, risk & insurance, the main responsibilities of the contractor, testing & defects and the last one is termination. These core clauses have many sub core clauses which are applicable to a project. Depending on the chosen tender procedure, six main contract types within the NEC3 can be selected with respect to the nine core clauses (Gould, 2007). Eventually, every building project is unique. Depending on the wishes of the owner, contract option A – F will be carried out. These main options are applicable on Design & Build contracts, but also on for example a Professional Service Contract. These main options display the manner of procurement and payment of a project. These options vary in risks carried by the Contractor (RM is a very important aspect in NEC3). An overview of the main options is presented in section 'Main options'. All these contracts are in the UK classified as Design & Build contracts, but have their own entity and have alterations regarding the common used Design & Build UAV-GC contract. For this research the British legislation is different from the Dutch. In England every contractual relationship and every details will be specified in the contract, while in Dutch contracts reasonableness and fairness often play an important part.

3.4.2 Main/ Payment options within NEC3

NEC3 is a family of contracts and is therefore a complex system. There are for example specific maintenance contracts or supply contracts next to the Design & Build contracts. To understand the family more in detail, there are main options/ 'payment' option available within each contract. These main options are summarized in table 3.2.

Table 3.2
Main/payment options within NEC3 adapted from ''NEC3 option'', by Kingskerswell-Bypass, 2007.

NEC3 Main/ Payment options

		Most risks carried by
Option A	**Priced contract with activity schedule** Contractor offers to provide work for a sum of money. Contract provide for certain risks carried out by Client: adjusting lump sum when a compensation event occurs. The activity schedule is written by the contractor. In pricing the activities, the contractor takes responsibility.	**Contractor** (since he knows which activities will be carried out)
Option B	**Priced contract with bill of quantities** Client provides a bill of quantity, priced by the contractor. Contract price is sum of all items in the bill. When quantities are not correct, payment is made to contractor. This option is not used for D&B contracts, since contractor is responsible who prepares the detailed design and plans.	**Client** for quantities **Contractor** for design
Option C	**Target contract with activity schedule** Mostly used option. The contractor tenders a target price using an activity schedule. The initial target is adjusted for compensation events (events as being the Client's risks), except for changes proposed by Contractor, to arrive at a final costs so that target remains equitable (Watermeyer, 2015). The contractor is paid his costs and the difference between 'final costs' and the amount paid to contractor is shared between the parties. Allows the Client more flexibility in developing own design	**Contractor** (when failing to notify a compensation event) & **Client** for design
Option D	**Target contract with bill of quantities** Similar as option C, but with bill of quantity. During project, the target price is adjusted to allow for changes in quantities and compensation events. Client carriers a greater risks because he is responsible for the quantities.	**Client**
Option E	**Cost Reimbursable contract** Contractor is paid the actual cost plus fee to protect the client from incompetence or inefficient working of contractor.	**Client** (complex projects were risks are high and work is not defined at the outset)
Option F	**Management contract** Most of the work is done by subcontractors, contractor manages the procurement and the work of the subcontractors. Contractor is paid for the costs of the subcontractors plus a management fee (Kingskerswell-Bypass, 2007)	**Client**

Summarizing contracts of NEC3

In the previous sections many contracts of the NEC3 family were mentioned that could be confusing to understand how it all works. To get a better understanding table 3.3 is structured to show the relations between the contracts and the main options within NEC3.

Table 3.3
Contracts in NEC3 family

				Main/ Payment options	Core clauses
Contracts		High risks	Low risks		Most NEC3 contracts have nine core clauses which follow the list below from the **ECC**:
	Works	ECC	ECSC (Engineering & Construction short contract)	Option A - F	1) general 2) The contractor's responsibilities 3) Time 4) Testing and defects 5) Payment 6) Compensation events 7) Title 8) Risks and insurance 9) Termination
		ECS	ECSS (Engineering & Construction short subcontract)	Option A - E	
	Services	TSC	TSSC (Term service short contract)	Option A, C, E	
		PSC	PSSC (Professional Service Short contract)	Option A, C, E	
	Supply	SC	SSC (Supply short contract)	Option A	

As you can see in the table, the main options A – F are not applicable to all NEC3 contracts. The contracts of NEC3 could be divided into works, services and supply. As mentioned before, there are short contracts for every contract when the perceived risks for both client and contractor are low and the required management skills are not that sophisticated (see column 'low risks'). The contract for constructing a complex building is marked blue and will be the main focus of this research.

3.4.3 Engineering and Construction Contract (NEC3 ECC)

According to NEC (2014), the most used option in the UK, Africa and New Zealand is the New Engineering Contract option C – Target Contract. Based on the available literature and case studies on the options within NEC3, main option C will be investigated further.

The National Economic Development Office (1982) defines a target contract as:

'' Target contract specify a 'best' estimate of the (total) cost of the work to be carried out. During the course of the works, the initial target cost will be adjusted by agreement between the client and the contractor to allow for any changes to the original specifications.'' (Chan et al., 2012)

Watermeyer (2015) defines a target contract as:

''A cost reimbursement contract in which a preliminary target is estimated and on completion of the work the difference between the target cost and the actual cost is apportioned between the client and the contractor on an agreed basis''.

For this research the definition of Watermeyer is used, because this definition covers most of the ambitions of NEC3.
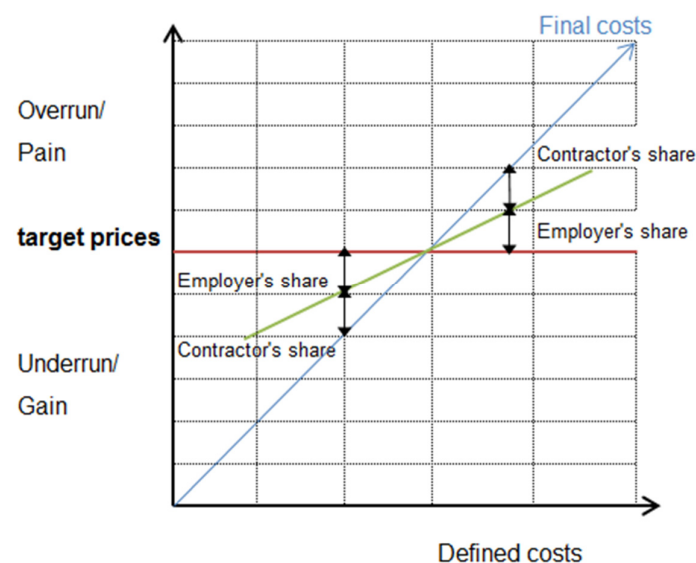
Figure 3.3 Target Contract option C with pain/gain mechanism (Broome, 2015)

Figure 3.3 illustrates the most common used contract type within NEC3, option C. An initial target is agreed between the client and the contractor. Each activity is priced as lump sum (contractor's defined cost when using activity schedule) uplifted by a 'fee' as percentage of subcontract work and the contractor's own direct work. 'Defined costs' in the target contract is described as amounts owed to subcontractors for work which was subcontracted plus the costs of components in the schedule of cost components for work not subcontracted. The initial target will be adjusted for compensation events, changes to the work information which are identified as the client's risks accepted by the client (further examined in section 'compensation events'), throughout the contract to arrive at a final target. In this case the target remains reasonable. The contractor is paid his costs, profit and overheads on a monthly

basis as the work proceeds (defined costs plus the fee). The difference between the final cost and the amount paid to the contractor when the work is done, is shared between the two parties (Watermeyer, 2015). The sharing mechanism of risk in the target contract is likely to reduce the occurrence of disputes (Kingskerswell-Bypass, 2007). In this way the client ensures that the contractor has no negative cash flow. This pain/gain mechanism is perceived to be a positive influence on the interaction of the stakeholders.

An important aspect of the target contract option C (with activity schedule) is the concept of disallowed costs, clause 11.2(25). Conflicts (and liability issues) often occur in a project through unapproved costs. A confusing part of the contract is dealing with the costs of correcting defects: disallowed costs are costs for correcting defects after completion while costs for corrections before completion is however allowed (Hawkswell Kilvington, 2012). Clients are expected to pay for the contractor to recover the defects when they arise prior to completion. However, the contract option C provides for an indirect benefit for the client. When a client pays the contractor to recover the defect, the 'defined costs' will increase what results in reducing the gain share of the contractor. In a worst scenario the contractor has to pay the client if the target cost is exceeded. This is an incentive for both parties to minimise defects to ensuring both shares in the end.
But questions arise concerning the potential risks and rewards arising from excesses or savings on the target cost. NEC3 has an incremental scheme which requires the client to state ranges of deviation from the target cost and corresponding share percentages.

Programme

NEC3 relies on there being an accepted programme. Popularly also called planning. The term programme as used in NEC3 is not a single document but a collection of documents which may include method statements, histograms, bar charts and network diagrams. An important difference with other contracts, is that every detail has to be laid down. Information ranging from which bolt should be used to the 'time risk allowance', all is stated in the procedures of the project. In NEC3 everything evolves around process management, planning and control (Roijers, personal communication, December 21st, 2015). When option C is applied, the contractor provides a programme with a cash flow forecast, called the 'cost loaded programme' that indicates how cash will be spent over time on a project. It gives weight to schedule components and helps to measure project status. Watermeyer (2015, p. 41) & Eggleston (2015, p. 202) use the definition 'Schedule of Cost Components instead of cost loaded programme. The contractor provides also information which shows how each activity on the Activity Schedule relates to the operations on each programme he submits. When the contractor fails to submit a realistic programme in the contract data then one quarter of the price for work done to date is retained in assessments of the payment
Eggleston (2015) argues that another characteristic of NEC3 is that it ensures that the contractor's programme does not become an excessive document by requiring the contractor to submit revised programmes at regular intervals (p. 159). These revised programmes should show the progress and the effect upon the timing, plans for dealing with delays and effects of compensation events and early warnings.
NEC3 requires the contractor to keep records of his costs for subcontractors plus the costs for components in the schedule including records showing payments made, accounts of

payments of defined costs and records relating to compensation events. The project manager should be able to inspect these records at any time: an **open book system.**

Clause 50.2 states that the project manager assesses the price for work done to date plus other amounts to be paid to the contractor at an assessment date (the clause states when these dates should occur). This assessment date should never be more than five weeks after the starting date. When for example a contractor chooses other (more expensive) materials than stated in the contract, the project manager only pays the costs stated in the schedule of cost components/cost loaded programme.

Concluding, planning and the control of the programme is very important in NEC3. The process and monitoring of the programme (and as an extension the payment) is one of the key items that makes NEC3 different.

Risk register

A risk register will be developed with respect to a proactive management approach (Goh & Abdul-Rahman, 2012; Yang & Zou, 2014). This register will originally contain risks identified by the contractor and the project manager (Eggleston, 2015, p. 6), but during the proceedings of the project the register will be further developed. Making alterations in the supply chain of a project due to uncertainties shows that flexibility is a very important aspect. Risks are associated with cost & time. The process of the identification of the risk in an early stage of the project allows the different stakeholders to examine how these risks could be managed before turning the attention to the cost and time implications (Gould, 2007). Therefore it is essential to map the risk, to minimize the uncertainties in an advanced stage and to prevent miscommunication concerning risk bearers. When choosing the main option of NEC3, the client is justified in asking how the various tender candidates handle the allocation of risk.

Early warning

A lot of researchers (Chan, Chan, Chan, & Lam, 2012; Gould, 2007; Manu et al., 2015) argue that an early warning system is an important element of risk reduction. Chan et al. (2012) concludes that the early warning clause 16.1 in the NEC3 contract encourages the proactive participation of the contractor, subcontractors and the project manager to give early warnings to the project team for matters that could increase the total of the price, a delay in completion, a delay in meeting a key date or impair the performance of the works in use. The contract requests a meeting to seek plausible solutions for reducing the impact of possible risks (Chan et al., 2012). There are clauses included in the NEC3 that require matters (for which an early warning have been given by the project manager or the contractor) to be entered in the risk register. These early warnings should be considered at those **risk reduction meetings.** The implementation of the early warning system in the contract has ensured that the status of NEC3 is more collaborative.

Early warnings are important in the process of the new concept of 'Compensation Events'. To be ahead of uncertainties, NEC implemented a core clause 'compensation events'. This assessment deals with variations, loss & expense and extensions of time and deals with the entire effect of an event on money and time (Eggleston, 2015). This concept will be elaborated in the next paragraph.

Compensation Events

Compensation events are 'variations, loss & expense and extensions of time; a single assessment dealing with the entire effect of an event on time and money'.

The NEC3 contract is dealing with compensation events in clause §60-65.
When such events occur and they do not arise from the contractor's fault, the contractor is entitled to be compensated for any effect the event may have on the price (Williams, Williams, & Ryall, 2013). Thus, compensation events are those which are not the fault of the contractor (Evans, 2013). A compensation event does not always results in a compensation for the contractor. When the contractor fails to notify a compensation event to the Project Manager within **8 weeks**, he loses his right to claim any additional time or money. However, when the Project Manager should have notified the event the Contractor will not be time barred (Evans, 2013). The early warning system ensures that the contractor will only be compensated when an early warning had been given based upon the date on which an experienced contractor would have recognised the need to give a warning. When a compensation event occurs and the contractor failed to give an early warning which he should have given, the event will be assessed as if there was given an early warning. This particular treatment is an incentive mechanism for the contractor because the project manager could use 'the benefit of hindsight' (Perception of the significance and nature of events after they have occurred) to decline the allocation of extra time or money to the contractor (costs which would not have been made) if an early warning had been given.

In the most used options of NEC3 A and C, the client will bear the costs in terms of time and money if a risk is covered by a compensation event. If a risk is not included in the contract, the contractor bears all other risks (Gould, 2007). Most claims for compensation events were mostly linked to changes in the works information.

''The work information specifies and describes the works and states any constraints on how the contractor is to provide the works''.

The works information is not only a specification of works; it includes forty-five possible clauses. It is of great significance for all involved stakeholders that all necessary information and detail is included in the contract.
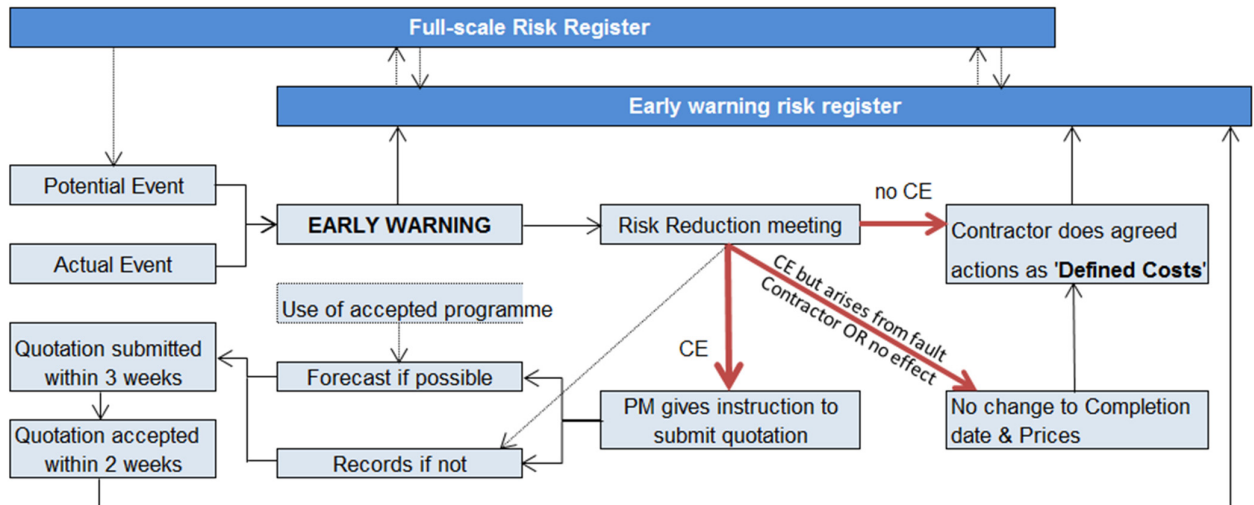
Figure 3.4 Dealing with changes during project NEC3 (Broome, 2015)

Figure 3.4 shows an overview of how NEC3 contracts handle changes during a complex project, regarding a risk register. As mentioned in the previous section, a 'risk reduction meeting' is scheduled when an **early warning** is given by the involved stakeholders. The red arrows illustrate the possibility of a compensation event (CE) for the contractor. Table 3.4 shows the listed compensation events in the contract.

Researchers of the NEC3 contracts often mention the word quotation (Evans, 2013; Gould, 2007; Watermeyer, 2015). When a compensation even arises from an instruction of the project manager, the contractor will be instructed to provide a quotation. A quotation must deal with all the effects of a compensation event on both money and time (Evans, 2013). This document must follow the procedures in the contract and includes details of the contractor's assessment. Also a revised programme should be included when the event effects the completion date.

Table 3.4
Listed events which apply to target contracts, retrieved from Eggleston (2015)

Clause	Listed event
60.1 (1)	Changes in the works information
60.1 (2)	Late access/use of site
60.1 (3)	Late provision of specified things
60.1 (4)	Stopping/suspension of work
60.1 (5)	Late/additional works
60.1 (6)	Late reply to communications
60.1 (7)	Finding of objects of interest
60.1 (8)	Changes in decisions
60.1 (9)	Withholding of acceptance
60.1 (10)	Searches for defects
60.1 (11)	Tests or inspections causing delay
60.1 (12)	Physical conditions

60.1 (13)	Weather conditions
60.1 (14)	Client's risk*
60.1 (15)	Take- over after completion
60.1 (16)	Failure to provide materials etc.
60.1 (17)	Correction of assumptions
60.1 (18)	Breach of contract by client
60.1 (19)	Prevention
X2.1	Changes in the law
X12.3 (6)	Changes in the partnering information
X14.2	Delay in making advanced payment
X15.2	Correction of a defect that is not contractor's liability
Y2.4	Suspension under HGCR Act 1996

Notifying compensation events is crucial for the NEC3 contract. All parties in a project are obliged to notify another party when becoming aware of an event. For example, a contractor should notify a project manager of an event which has happened or which he expects to happen as a compensation event within eight weeks of becoming aware of the event. If he does not notify the project manager, he is not entitled to change the completion date or to a change in the prices. This notification process is introduced to reduce the occurrence of disputes. Nowadays stakeholders are going to search through their records for evidence that could support an argument that they did comply with the notification requirements stated in the contract. However, NEC3 notifications (early warnings or notifying compensation events) must be given in a separate document which can be read and copied in order to be valid. This ensures good controllability, communication and management (Hawkswell Kilvington, 2012). On the other hand, conservative experts in the construction industry could consider this notification process as an administrative burden.

Mutual trust

The NEC3 contract includes an obligation for the stakeholders to act in a spirit of mutual trust and co-operation. It is arguable if these concepts are legally enforceable (Eggleston, 2015, p. 84). The difficulty is determining the function these concepts are intended to serve. Clause 10.1 in the NEC3 contract states that the client, the contractor and the project manager should act as stated in the contract and in a spirit of mutual trust and co-operation. Further research should examine if this clause is stated correctly and if the clause works (because of cultural differences).

3.4.4 Comparison with other integrated contracts

The building process is becoming increasingly complex due to the involvement of many stakeholders. Constructions have to meet technical, functional and economical requirements. The manageability of this complexity is a necessity.

NEC3 is an international alternative of the UAV and UAV-GC. The UAV has been used for decades and is the basis of the relation between client and contractor, for the execution of building projects. The UAV 1989 and its successor 2012 form the basis of the traditional building contract.

To deal with the higher demands of the construction industry, the integrated contracts were introduced 16 years ago with the UAV-GC as juridical basis. The most common used integrated contract is Design & Build. In the case of a Design & Build contract, the design and execution of works will be carried out by one party. The main difference between these two systems is that the UAV-GC covers a greater proportion of the building process, both design and execution and sometimes maintenance. The traditional system of UAV only operates in the execution phase. The risks are assigned to the client. With the Design & Build collaboration the client sets requirements and must uphold his own quality management system and oversees the process from a distance. The demand specifications differ in the two contracts, were the UAV is very detailed in the building specifications and the UAV-GC is known for its functional specifications.

The shift from the traditional collaboration to the Design & Build collaboration is especially beneficial for clients, since the risks are more and more allocated to the contractors.

But the perception prevails that the Design & Build contracts have no 'additional work' and thus will be more beneficial. The distant control of the client appears to be more difficult, because the clients want to have and bring new insights in the project (a more direct involvement) (Koning, 2014). When this happens, there is a shift of the risks to the clients. In appendix A the role of HEVO B.V. in the building industry is elaborated (which describes their project manager's role as the delegated commissioner of the client) and the project manager model IPM of HEVO will be introduced (IPM stands for Integral Project management, and operates under the UAV and DNR).

British public procurement projects are managed by the NEC3 contract for 20 years and this contract is comparable with the UAV-GC but with more clarity. The advantages of NEC3 in comparison with the UAV-GC is that NEC3 is more flexible. NEC3 is a system of agreements that could be applied to multiple building organisation forms. The UAV-GC is seen as vaguer and less focused on cooperation because the contract is nothing more than an input form that has to be modified strongly for each individual project and because of the prevailing own interests.

Alterations in UAV-GC have extreme consequences that will result in higher costs for the client. There is also a need for common interest instead of individual interests.

The detached position and the reduced involvement are an obstruction for using the UAV-GC. Koning (2014) argues that providing functional specifications by the client will cause difficulties because most clients do not have the specific knowledge.

NEC3 involves a much broader set of agreements than is customary under the UAV-GC (Brink Groep, 2013a). Were the UAV-GC includes all the information of a specific project in the

general provisions, the NEC3 contract has this uniformed and is in this way applicable for many unique projects.

NEC3 is more focused on cooperation throughout the chain. Especially the target contract (NEC ECC-C) encourages the client and the contractor to work together to control the risks and exploring ways of optimising the construction project (Brink Groep, 2013a).

The intention of NEC3 is that each party is generally responsible for the design which it undertakes (Eggleston, 2015). In this manner the contract provides single point responsibility on design when the works information requires the contractor to undertake either all the design or none of the design.

Another example that NEC3 could substitute the Design & Build contract, is that in UAV-GC Design & Build contracts it is generally accepted that in the absence of express provisions there is an implied term that the finished works will be reasonably fit for their intended purpose. This puts the liability of the contractor for his design on a different legal basis from that of a professional designer. Contracts do not normally imply terms of fitness for purpose for the supply of professional services. The duty of a professional designer is to use reasonable skills and care. When a failure in design occurs, the difference between these two liabilities can be critical. To relieve the contractor of the higher standard of liability imposed by fitness of purpose some Design & Build contracts limit the standard of the contractor's design liability to the same as that of a professional designer. NEC3 does not have such limitations of liability. The literature states (Eggleston, 2015) that in the most cases the contractor's liability for his design is on a fitness for purpose basis. This has to be validated by the case study. All the above mentioned differences are bundled in table 3.5.

Table 3.5
Comparison (advantages) NEC3 to other contracts (Eggleston, 2015; Koning, 2014)

	NEC3	UAV- GC Design & Build	UAV Traditional contract
Time, Planning & control	Key dates, access dates, compensation events as assessment of time, early warnings, defects date , flexible	Contracts are success only when there is strong supervision Alterations lead to extreme consequences	Working sequentially, not integrated. Delay in one task provides for delay in other tasks
Specification	Works information, very detailed	functional specifications	Very detailed specifications Output requirements
	Standard provisions applicable to entire range of situations: no contractor's design to full contractor's design	Drafted for contractor's design	Drafted for client's design, flexibility operates within a framework of recognised rules
	NEC3 is comprehensive, no additional project specific conditions are needed (Brink Groep, 2013b)	Next to general provisions mostly additional project specific conditions needed	Next to general provisions mostly additional project specific conditions are needed
Responsibility / liability	Party responsible for design which it undertakes, allocation to best party to control it (single point responsibility)	Design responsibility for contractor	Design responsibility client, liability contractor after completion neglected
	Strong engagement Client	Client decides his involvement	Client as controlling factor
Risks	Shared risk mechanism, allocation risk to parties best able to control it	Shift allocation to contractor	Client
Quality relations/ Quality performance	Early warnings, risk mitigation strategies		
	Safety requirements	Safety requirements	Safety requirements
	High quality tender	Quality tender	Quality tender
Soundness of business	Open book (cannot hide problems)	Postponing problems to the last moment	Postponing problem
	Mutual trust	Individual interest	Focus not on common interests
	Stating defects date in part one of contract data for contractual end of liability of contractor	Defects liability period standard commence at take-over	Limited liability contractor after completion when latent defects occur
	Technical expertise	Technical expertise	Technical expertise

This chapter elaborated on the British construction contract NEC3 ECC-C (in further research the abbreviation NEC3 is used). With this chapter the first two research questions have been answered. The most important aspects to carry out further research on NEC3 are RM tools as the programme, early warning, compensation events and risk register and SM tools as the gain/pain mechanism, mutual trust and open communication system.

3.5 Risk management (RM)

The large scale of NEC3 projects ensure that there is a high need for good problem solving procedures. NEC3 attaches great importance to the management of construction risks (early warning system and compensation events) and the management of stakeholders (open book system, mutual trust). The next two chapters give a good overview of how previous studies tackle the complexity of these two concepts: not particularly what to do when risk of disputes occur or problems concerning stakeholder's interest occur, but providing a range of good management factors which would ultimately lead to a higher success of project. These chapters would ultimately help to understand the positive and negative contributions of the NEC3 contract on the current state of the two project management tools.

The concept of risk is multi-layered, but in the construction context it typically refers to the probability of a prejudicial event occurring during the lifespan of a construction project (Abderisak & Lindahl, 2015; Serpella et al., 2014). The definition of RM has the same meaning in different cultures and has not change over the years, because it always involves minimizing losses and enhancing profitability (Akintoye & MacLeod, 1997). Although construction projects and the related collaborations changed remarkably the last decade resulting in a more complex risk analysis, risks in construction projects are perceived as events that influence project objectives of costs, time and quality according to Akintoye &Macleod (1997) and continues to be perceived in 2015 (Taillandier et al., 2015). RM has widely been recognized as a critical domain in the field of project management. RM has everything to do with the **planning and control and** the **soundness of project team**. Many recent studies argue that project related risks need to be managed on a proactive basis (Goh & Abdul-Rahman, 2012; Mills, 2001; Taillandier et al., 2015). The sources of the risks should be analysed and each stakeholder in a construction project should assess their risks and take actions to mitigate the possible consequences (Prum, D.A., Del Persio, 2009). Many researchers have tried to fill the gap of solely investigating the risks on the one hand and map the relations of stakeholders on the other hand, by looking at the interrelation of these two aspects. This research will continue to build on these previous studies to fill this gap, by introducing the New Engineering Contract 3. This new collaboration is an uncharted territory for the Dutch construction industry and is elaborated in section 3.4 with the early warning system and the compensation events as leading clauses.
In this research the definition of RM is:
 '*Adopting measures to identify risks, to analyse and respond to these risks, in order to reach the desired effect on the company or project objective'.*

RM is not a goal in itself, it is part of other processes and it contributes to issues like the reduction of failure costs, delays and disputes, the control of complex and unsafe situations & the relationship with innovation and integrity.

3.5.1 The changing European society concerning RM

The evaluation of risks in construction projects has been done for many years. RM has traditionally been conducted instinctively, with suggested risks managed by judgement (Akintoye & MacLeod, 1997; Mills, 2001; Serpella et al., 2014). Especially in unique complex construction projects providing situations in which stakeholders have no previous experience, risks are difficult to manage. Project management is established, to reflect the requirements

from both flexibility and planning & control, stressing the need for sound planning and control, together with RM (Guo et al., 2014; Koppenjan, Veeneman, van der Voort, ten Heuvelhof, & Leijten, 2011). The traditional project management approach has a stronger focus on understanding the involved risk beforehand and trying to avoid them. ''The project manager should take actions to mitigate and minimize foreseeable risk-based failure'' (Royer, 2000, as stated in Lehtiranta, 2014). Other studies (Gould, 2007; Guo et al., 2014; Poppo, Zhou, & Ryu, 2008) focus on an alternative approach of being flexible when risks occur anyway. The last decade, a RM principle states that 'even with the best planning it will not be possible to gather all relevant information'. The project options, accompanied by the project management should remain open so that uncertainties can be resolved (Koppenjan et al., 2011; Lehtiranta, 2014a, 2014b). More recently, Eggleston (2015) argues that the guiding principle on allocation of risk is that the risks should be allocated to the party best able to control it (p. 15). Nowadays it is often accepted that the contractor should not be required to carry risks that arise from matters beyond the influence of either party or which are uninsurable.

3.5.2 The general principles of good RM

Researchers are looking for failure factors in order to contrive preventive strategies for the future (Davis, 2014; Khan, Gul, & Shah, 2011). There are a lot of techniques to manage the involved risks in a project. However, the selected RM tools have to be in line with the project objectives (Forbes, Smith, & Horner, 2008; Goh & Abdul-Rahman, 2012; Huijbregts, n.d.). Abderisak & Lindahl (2015), Goh & Abdul-Rahman (2012) & Guo et al. (2014) already conducted a review on different RM tools. These studies revealed that only a few techniques are actually used in the construction industry. The most common identification techniques for risks are case-based approaches, checklists and brainstorming (Lyons & Skitmore, 2004). As mentioned in the previous section, subjective judgement and intuition are also used in assessing the risks (Goh & Abdul-Rahman, 2012; Serpella et al., 2014). Dikmen, Birgonul, Anac, Tah, & Aouad (2008) argues that the future needs a shift from 'management of adverse effect' to learning from risks to eliminate risk on beforehand.

Various articles were studied that name different RM tools in their research. To get a better overview of these tools these various articles should be compared. To be able to compare the observed literature, matrix 3.1 is structured for this research that arranges the various tools by means of the observed literature with the authors in alphabetical order. For example Akintoye (1997) names experience, checklists and knowledge as tools to manage risks in a construction project where Ebrahimnejad (2010) names checklists and brainstorm sessions as good techniques to manage risks. All the tools are bundled horizontal and as can be seen in the self-structured matrix some articles mention the same tools. There are definitely more tools for setting up RM, but these nine tools are the most used tools in the observed literature for this research.

Matrix 3.1
Used RM tools according to different articles

Author	Tools for setting up RM								
	Intuition/ experience	Check lists	Risk register	Probability matrix	Case/ knowledge based approach/ learning based	Factor Analysis	Fuzzy logic	FMEA	Brain storming
Akintoye & MacLeod, (1997)	X	X		X					
(Chan, Chan, Lam, (2011)						X			
Cheng & Lu (2015)	X			X	X		X	X	
Dikmen et al. (2008)				X	X				
Ebrahimnejad, (2010)		X							X
Forbes et al. (2008)	X	X		X	X				X
Gehner, Halman and, & de Jonge (2006)	X								
Goh & Abdul-Rahman (2012)		X							X
Gould (2007)			X						
Guo et al. (2014)			X		X				
Ke, Wang, Chan, & Lam (2010)		X							
Khazaeni, Khanzadi & Afshar (2012)					X		X		
Lam, Wang, Lee, & Tsang (2007)					X		X		
Lyons & Skitmore, (2004)		X							X
Marhavilas (2011)		X		X					
Os, Berkel, Gilder, Dyck, & Groenewegen (2015)	X								X
Serpella et al. (2014)					X				X
Taroun (2014)		X	X						
Watermeyer (2010)			X		X				

As can be seen in the matrix, checklists and case & knowledge based approaches (highlighted in grey) are the most mentioned tools by the different observed papers for this research to identify and assess risks. Just as the NEC3 contract, other articles such as Gould (2007), Guo et al. (2014), Taroun (2014) and Watermeyer (2010) also mention a risks register as a helpful tool. Watermeyer (2010) provides an example of a register structure, showed in table 3.6. The actions to reduce or to avoid risks can include 'Actioned' (A), 'Take no Action' (N), 'Monitor and review from time to time' (M) and 'Take action' (T).

Table 3.6
Structure of the Risk Register and example of entry.

Entry date	Description of the risk			Action to avoid or reduce risk			Action status
	Risk event	Cause	Possible outcome	Description of action	Responsibility for action	Timetable for implementation	
13-10-2015	Supply building component delayed	Design defects	Completion delayed, less time to meet first Key Date	An alternative design using different equipment	Contractor	01-11-2015	T

Note: Reprinted from ''NEC3 Briefing Note - managing project risks through the NEC3 Engineering and Construction Contract'', by R. Watermeyer, 2010, *South African Institution of Civil Engineering, 18.*

3.5.3 Classification of risks

Researchers use many classification systems for RM (Rasool, Franck, Denys, & Niandou Halidou, 2012), but most of the articles consider the source of the risk as the most important aspect of risk identification. To get a good overview of used classification systems different articles should be compared. In the following self-structured matrix 3.2 the observed literature on classification systems is vertically arranged in alphabetical order. The mentioned classifications are linked to these articles. There are eight classifications extracted from the observed literature. Some articles such as Dikmen et al. (2008) mention one classification system, others (Hwang & Ng, 2015) mention three possible classification systems.

Matrix 3.2
Dividing risk into different classifications according to various articles

Author	Classification of risks							
	1 Internal & external risks	2 Primary & secondary risks (nature & magnitude)	3 Different phases of the project	4 Allocation to different stakeholders	5 Importance (low, middle, high)	6 Dynamic /static	7 Positive/ negative Opportunity/threat	8 Acceptable/unacceptable
Dikmen et al. (2008)	X							
Goh (2012)		X			X			
Hwang & Ng (2015)	X			X	X			
Kersten (2013) HEVO					X			X
Ke et al., (2010)				X				X
Marhavilas (2011)					X			
Mehdizadeh (2013)	X		X		X	X		
Purdy (2010)	X							X
Rafindadi et al. (2014)	X						X	
Wang & Yuan (2011)	X				X			
Wibowo & Mohamed (2010)				X				
Zou et al. (2007)	X	X			X			

When looking at this matrix, the most used technique to classify risks, is to divide the risks in external and internal risks in combination with the importance. HEVO also works according to this principle (Kersten, 2013).

This matrix shows that most literature does not address the difference of project-specific risk and general/governance risks. Ebrahimnejad et al. (2010), Hwang & Ng (2015) (Lam et al. (2007), Lehtiranta (2014b) & Wibowo & Mohamed (2010) argue that there is a need for a shift in the risk classification to a more project-specific classification, because every project is unique and complex.

The first step in the RM activities of most companies is the **identification** of risk items at an early stage. In this stage mainly the external risks are identified.
There is a difference between the internal and external risks of a project organization. Internal risks are related to the ability of the organization to work together in an effective way. These internal risks represent the prominence of the organization itself as a potential risk or opportunity (Lehtiranta, 2014b). This is caused by different contracting parties and the fact that TMO's have to deal with a lack of prior collaboration. Most studies are talking about

external risks (also called technical risks) which involve all other events that the project organization experience, regarding financial and political issues. Researchers recommend to combine these two risks elements in future research (Purdy, 2010).

As mentioned in previous section 3.4, NEC3 also identifies certain risks in advance, but due to the flexible character of the contract, alterations and additions are made during the project. During this stage of identification, client objectives, contract clauses and project requirements are also defined. When the identification of the risks is carried out, the **assessment** of these risks is performed by quantification of the risk items (Dikmen et al., 2008), by means of the mentioned RM tools, shown in matrix 3.1. Namely in this stage, the internal factors that may affect manageability of risks are taken into account so that realistic estimates can be made. These risks have their origins within the TMO's of for example Design & Build collaborations, arising from their rules, policies, processes, decisions, behaviours or cultures. **Handling** the risks is the third stage, appropriate response actions can be chosen for the identified risk factors. Secondary risks are defined (both internal and external). The **monitoring** phase is about data capturing of risk events that actually happened. Handling risks during the project is about execution of action plans, were there is a cyclic relationship between monitoring and handling processes in NEC3 contracts (Gould, 2007).

3.5.4 Planning & Control (PC) in RM

As mentioned in the first paragraph of this chapter, risks in a building project refer to the probability of a prejudicial event occurring during the lifespan of a construction project and RM is a project management component that adopts measures to identify risks, to analyze and respond to these risks, in order to reach the desired effect on the company or project objective. The structured matrices in this research that compared different literature on the RM tools showed that there are a lot of ways to control the project objectives (for example the use of a risk register by Gould (2007) and Guo et al. (2014). These RM tools and the classification of risks (structured matrix 3.1 and 3.2) help to get a clear view of the possible positive and negative effects certain events could have on a NEC3 project. The planning of a project and in this case a NEC3 project is considered to be critical for project success (Zwikael, Pathak, Singh, & Ahmed, 2014). The programme in the NEC3 ECC option C is a good example of how much value this new collaboration attaches to the control of processes.

Literature is inconsistent concerning the importance of planning for success. Pinto & Slevin (1987) argue that planning has definitely a positive impact on the project success, while Dvir & Lechler (2004) argue that there is a weak connection between planning and success of a project. This suggest a difference in the importance of planning regarding various project scenarios. High risk projects have a great challenge in achieving a successful delivery of a project. Planning and control could help to deal with uncertainty in this project development. As a conclusion, risks should be mapped and the project has to be flexible in handling unforeseen risks to have a better chance of success. The assumption in this research is made that planning and control are necessary components to be able to solve problems that have occurred or could occur in the course of the project.

Now there is a clear view of the used risk (project) management tools in building projects and in NEC3 projects, it should be clear that the control of the risks that emerge from these tools

is important to achieve a qualitative project outcome. The early warning system in NEC3, the risk register, the compensation events are all methods to manage and control disputes (problem solving), the process and success of a project. For future research it is important to see how important the planning and control is for the interrelation between different factors in the NEC3 that are all meant for the enhancement of success and the reduction of risks, problems, disputes and ambiguities

3.6 Stakeholder Management (SM)

Construction management academics have devoted comprehensive research efforts on managing construction project stakeholders in recent years (Mok et al., 2014). Most stakeholder literature concentrates on the bilateral relationships of the individual stakeholder and the organization. Missonier & Loufrani-Fedida (2014) argue that this bilateral analysis should integrate the complex arrangement of multiple and interdependent relationships in stakeholder environments (p. 1109). The 21st Century is more stakeholder focused with project success depending on the project life cycle (short & temporary goals) and not on the extended organization (long term) (Davis, 2014; Turner & Zolin, 2012). Combining the short and long term goals, thus examining how the organization views a project is a new research field (Davis, 2014). A working definition of SM in this research will be:

'*an effective systematic approach for project managers to accommodate stakeholder interests and to achieve the best value of project outcome, by bringing the stakeholder concerns to the surface and developing robust stakeholder relationships in complex project environments'* (Bourne & Walker, 2005, as cited in Yan et al., 2014)

Because SM is a great understanding a specific focus will be applied for this research. NEC3 attaches great importance to mutual trust and the open transparent communication system, these concepts should be leading in the search for reviewing literature on stakeholder relations. The main focus of SM in this research will be trust, soundness (reliability & solidity) and quality of the performance of a project. Paragraph 3.6.1 Trust will be supported by a maturity model on the relationship between a contractor and a client to give an extra dimension on the importance of the stakeholder interaction in a building project.
In this research the main focus is NEC3 projects what means that the stakeholder relationships are mostly temporary. Before starting elaborating on trust, soundness and quality and performance of stakeholders a definition of temporary multi organizations will be given.

Temporary multi organizations (TMO)

The term 'temporary' relates to the project-based nature of certain organizational structures. RM & SM are important aspects for multi-organizational projects because the stakeholders' goals and management structures are partly shared in an multi-organizational project and partly determined by the stakeholders' clients (Lehtiranta, 2014b).
In this research the working definition of temporary multi-organizations is:
''A group of people responsible for complex tasks over a limited period (project-based) and are typically cross-functional, consisting of members who have complementary skills and come from separate, fragmented but interdependent companies who share pre-defined goals and schedules.''

Hanisch & Wald (2014) conclude that the limited duration and non-routine tasks pose specific challenges to the coordination of TMO's Integrated collaborations such as D&B, Design, Build and Maintain & NEC3 are examples of multi construction collaborations, where different disciplines work together to reach a mutual goal. To achieve a successful temporary project, ongoing interaction is necessary to reach common goals (Yang & Zou, 2014). Project team, organization, multiple stakeholders are called in this research and are all covered by TMO's.

3.6.1 Trust (T)

An important aspect of NEC3 contracts is mutual trust between the stakeholders. Eggleston (2015) argues that the English law took a step forward, to include an obligation for the stakeholders to act in 'a spirit of mutual trust a cooperation'. Whereas the Dutch contracts have a more reasonableness and fairness attitude when it comes to cooperation, the NEC3 creates such an approach by the implication of a duty to co-operate wherever it is reasonably necessary to enable other stakeholders to perform his obligations.

Chow, Cheung, & Chan (2012), Laan et al. (2011) and (Manu et al. (2015) confirm the difficulty of the psychological concepts 'good faith' and 'mutual trust' and the determination what function they are intended to serve. Many researchers worry that these concepts are questionable when they are legally enforceable (Eggleston, 2015). The debate on the proper construction will probably run until it is settled in court. At the end of this part, a maturity model (Meng et al. 2011) is presented on the relationship between the contractor and client in a construction projects and how this relation could be improved by assessing the relations by means of different levels. This model could be used and adapted to measure the trust level of a temporary project that is executed according to the NEC3 contract. This is definitely not legally enforceable, but helps to understand how certain construction contracts are judged.
A lot of studies investigated the importance of trust in construction projects. Manu, Ankrah, Chinyio, & Proverbs (2015) argue that trust is essential for achieving flexibility, but that there are still challenges as to how a trust-based collaboration can be realized, especially when construction projects deal with multiple stakeholders. (Bakker, 2010; Buvik & Rolfsen, 2015; Laan, Noorderhaven, Voordijk, & Dewulf, 2011; Pinto, Slevin, & English, 2009) argue that social relations and trust will be affected by the duration of temporary organizational forms. Previous studies (Laan et al., 2011; Pinto et al., 2009; Suprapto, Bakker, Mooi, & Moree, 2014) focus on the relation between owners and main contractors through the use of collaborative procurement procedures and contracts. There is limited research available on the trust development between a contractor and subcontractors (Manu et al., 2015). For example, HEVO is active as managing contracting authority, project manager & consultant, who has a lot of contractual relationships with architects, constructors etc. Gad & Schane (2014) conclude that there is still a knowledge gap in areas of project costs, risk and contract's relations to trust. Further research should examine trust factors in construction projects, between contractors, project managers and subcontractors. For this reason, the following definition of trust is used in this research:

'' The belief that the stakeholders' decisions in a temporary multi organization will be beneficial for all parties which will allow to limit the inspections'' (Radziszewska & Szewczyk, 2014).

Matrix 3.3 was structured for this research to be able to classify the observed papers according to research question 4 mentioned in section 3.3. This matrix explores articles concerning trust development factors in construction projects. To structure this matrix, various articles on trust development are investigated and arranged in alphabetical order and are linked to their mentioned factor that result in trust development. As showed in the matrix, ten factors were extracted from the observed literature. An interesting aspect in this structured matrix is an article of Chow et al. (2012), which describes the negative effect formal control has on trust

development. They describe formal control & monitoring as a deterioration of trust, while others (Laan et al., 2011; Manu et al., 2015; Mok et al., 2014) argue that monitoring and formal control have a positive effect on trust development.

Matrix 3.3
Factors resulting in trust development

Author	Factors resulting in trust development									
	1	2	3	4	5	6	7	8	9	10
	Economic climate/ Culture/ Reputation	Job perfor-mance	Formal control & monitoring	Open commu nication	BIM	Net-working	Value congruence	Clear role expectations / tasks	Project time	Prior ties
Abderisak & Lindahl (2015)					X					
Buvik & Rolfsen (2015)				X				X	X	X
Chow, Cheung, & Chan (2012)		X	(trust deteriorati on)			X	X			
Cheung et al. (2011)				X				X		
Crespin-Mazet et al (2015)				X	X					
Huai et al. (2012)		X					X	X		
Laan et al. (2011)		X	X	X		X				
Lehtiranta (2014)								X	X	
Manu et al. (2015)	X	X	X		X					
Mok et al. (2014)	X	X	X							
Pinto et al. (2009)	X			X					X	
Poppo et al. (2008)						X		x		
Suprapto et al. (2015)			X	X				X		

As can be seen in the matrix job performance, open communication and clearly defined job task are the most mentioned aspects in the development of trust between parties in the observed literature for this research. Hanish & Wald (2014, p. 198) and Suprapto et al. (2014, p. 666) argue that informal coordination mechanism such as transparency and open communication enable trust and the accelerating of information processing and the exchange of knowledge. It could be concluded that these three factors are important for the development of trust. By means of this matrix and conducted research on trust, different trust models of inter-organizational trust are examined, shown in table 3.7. The different factors

resulting in trust between different stakeholders evaluated in matrix 3.3 can be categorized into these existing classifications of trust. The fourth column of table 3.7 arranges the numbers one to ten which are equivalent to the ten factors in matrix 3.3.

Table 3.7
Structured table that presents different trust models

	Trust models		
	Classification	Description	Involved factors matrix 3.3
Cheung et al.(2011)	System-based trust	Performance and faith in the system	3, 8
	Cognition-based trust	Built on knowledge and expectation	1,2,4,9
	Affect-based trust	Addresses feelings and emotions	6,7,10
Hartman (2002) Zaghloul & Hartman (2003)	Integrity-based trust	One party concerns the other party's benefits	
	Competence-based trust	Having specific and skilled ability	2
	Intuitive-based trust	A feeling based on reason or evidence	
Kadefors (2004)	Calculus-based trust	Trustor perceives that the trustee intends to perform an action that is beneficial	
	Relational-based trust	Repeatedly interacting	6,10
	Institution-based trust	Role of institutions in shaping trust conditions	1
Lehtiranta (2014) Das & Teng (2004)	Risk-based trust	To trust someone is to take risk with the trustee	
	Faith-based trust	Trustee has good intentions in the relationship and will carry out in good faith	7
Ning & Ling (2015)	Goodwill-based trust	Mutual expectation of open commitment to each other	7
	Continuity-based trust	Trust evolves around continuity of relations	10

Looking at the two matrices, the classification of Cheung et al. (2011) covers most of the factors extracted from the observed literature.

Recent studies (Cheung, Wong, Yiu, & Pang, 2008, 2011; Doloi, Iyer, & Sawhney, 2011; Gad & Schane, 2014; Huai, Faheem, & Yang, 2012; Ning & Ling, 2015; Suprapto, Bakker, & Mooi, 2015; Xiong, Skitmore, & Xia, 2015) used SEM to measure the importance of certain trust factors and to determine whether the number of factors and the loadings of measured/observed items on the factors are in line with the assumed theory. SEM tests and describes the relationship between two kinds of variables, namely latent variables and observed variables. The latent variables have an abstract character and cannot be observed directly and observed variables contain objective facts and are easier to measure (Xiong et al., 2015). SEM has the ability to isolate observational 'error' (the difference between measured value and its true value) from measurement of latent variables. The goal is to create indexes

with variables that measure similar things, for example the overall project success within a NEC3 collaboration. For example, it is possible that variations in a couple of observed variables reflect the variations in two unobserved variables. The factor analysis within SEM searches for this joint variations in response to unobserved latent variables.

Other studies used case studies to study how prior ties influence trust development in organizations (Buvik & Rolfsen, 2015). Meng (2011) developed a **maturity model** that measures the relationship level between a client and supplier.

The last mentioned tool created by Meng will be further elaborated in the paragraph on the next page because with some alterations this model could serve as a validating tool when measuring the trust level in a project team

Relationship level between client and contractor

This chapter on trust showed that the literature on measuring trust is scarce. The factors resulting in trust and the classification systems do not enhance the measurability of trust in a quantitative way. As mentioned in the previous paragraph, Meng, Sun, & Jones (2011) have developed a maturity model for supply chain management in the construction industry that especially focuses on the relation between client and supplier (relationship client and contractor or contractor subcontractor). This tool could help to quantitatively measure the relation between client and contractor and to determine the level of relationship they are in. In the article the model is evaluated through a series of expert interviews. It could help construction organizations to assess the existing relations within the project team and identify key areas for further relationship improvement (Meng et al. 2011). Other researchers also have tried to examine the process which supply chains of a project go through in an attempt to improve their effectiveness. Varoutsa & Scapens (2015, p. 68) and Wendler (2012) argue that different maturity models were developed to provide a framework for studying the maturity process, such as the maturity model of Lockamy & McCormack (2004) and (Mortensen, Freytag, & Arlbjørn (2008). For this research the maturity model of Meng et al. (2011) is preferred over other maturity models, because the model of Meng comprises the most relevant criteria and sub criteria that could be applied to a contract (observed maturity models were originally applied in the supply chain management).

In table 3.8 the maturity model of Meng et al. (2011) is presented. Level 1 (price competition) in the maturity model can be interpret as a win-lose relationship and level 4 (partnering) as a win-win relationship. As can be seen in the table, the NEC contract is situated in the second (Quality competition) and the third level (Project partnering), were there is a win-partial win of a win-win situation where it implies a partnering situation for one project where stakeholders work collaboratively together in an integrative organization. In this model 8 main criteria are presented, of which trust, collaboration, communication, problem solving, risk allocation and improvement during project are the most important aspects that enhance the quality of the relationship. For further research the maturity model could be transformed into a maturity model to measure the level of trust between a client and a supplier. A case study on NEC3 should be introduced in further research to measure the trust levels. This idea is adapted from (L. Cheung, 2015), who measured the trust level of NEC3 ECC, FIDIC and UAV-GC 2005 by evaluating different case studies.

Table 3.8
Maturity model on the relationship between employer and client

Main criteria	Sub criteria	Level 1: Price competition	Level 2: Quality competition	Level 3: Project partnering	Level 4: Strategic partnering/ alliance
1 Procurement	Selection criteria	The lowest price	Cost and quality	Multi-criteria from short-term perspective	Multi-criteria from long-term perspective
	Procurement route	Single-stage tendering	Two-stage tendering	Negotiation or tendering	Direct negotiation
	Form of contract	JCT	JCT/NEC	NEC/PPC 2000/JCT CE	MEC/TPC 2005/JCT CE/ Bespoke contract
2 Objectives	Objectives alignment	Only self-objectives	Mainly self-objectives	Mutual objectives in a project	Mutual objectives in the long-term
	Benefits	Win-Lose	Win-Partial Win	Win-Win in a single project	Win-Win in the long-term
	Continuity of work	No continuity of work	Prospect of future work through tendering	Preferred suppliers	Guarantee for future work
3 Trust	Type of trust	Contractual trust	Competence trust	Short-term goodwill trust	Long-term goodwill trust
	Confidence in others' behaviour	Little confidence	Some confidence	Much confidence	Full confidence
	Monitoring others' work	Checking and double checking	Checking somewhat reduced	Checking greatly reduced	Checking almost unnecessary
4 Collaboration	Working relationship	Confrontation or arm's length	Limited cooperation	Collaboration	Close collaboration
	Mutual help	No support for the weaker	Support only with the issues related to self-interest	Often support for a weak partner	Always support for a weak partner
	Culture	Mutual blame	Self defence	Abandon of blame culture	Problem solving focused culture
5 Communication	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly
	Cost data transparency	No cost transparency	Little cost transparency	Open book costing between two parties	Open book costing throughout the whole chain
	Sharing learning	No sharing learning and innovation	Little sharing learning and innovation	Sharing learning and innovation	Continuous sharing learning and innovation
6 Problem solving	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain
	Avoidance of recurrence	Problems often recur	Sometimes problems recur	Few problems are repeated	Rare problems are repeated
	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level
7 Risk allocation	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term
	Balance of risk and reward	No rewards for the party taking the risk	Some rewards for the party taking the risk	Often appropriate rewards for the party taking the risk	Always appropriate rewards for the party taking the risk
8 Continuous improvement	Joint effort	No joint effort for improvement	Limited joint effort for improvement	Joint effort for better ways of working	Continuous effort for better ways of working
	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; Irregular but formal feedback	Common measures; Regular and formal feedback in a project	Common measures; Formal, regular and continuous feedback
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives

Note: Maturity model. Reprinted from ''Maturity model for supply chain relationships in construction'', by X. Meng, M. Sun, M. Jones, 2011, *Journal of Management in Engineering*. Copyright 2011 by American Society of Civil Engineers

As mentioned in the introduction, there is an interdependence between culture (marked in table 3.8 as red) and the nature of working relationships (Suprapto et al., 2014). This should be taken into account when exploring a case study regarding the NEC3 contract. Trust could be perceived differently per culture, the goal is to find out if the trust aspect mentioned in the

NEC3 contract is internationally applicable. According to Hofstede (2015) the Dutch culture differs from the British culture in terms of the Feminine & Masculinity index. The British culture is performance oriented what relates to masculinity, whereas the Dutch culture is co-operation oriented what relates to 'feminine'. However, a temporary project could be managed by a performance contract (NEC ECC-C) and at the same time conducted by a project team that is co-operation oriented. A masculine/performance aspect of the contract is the pain/gain share mechanism of the target contract. In this way enforceable trust is implied (good performance trust, rewarding and punishing the contractor) but also intrinsic trust (vulnerability) stirred in other matters of a NEC3 projects.

Summarized, the maturity model of Meng (2011) could help to verify certain propositions in the literature on NEC3 by introducing a case study of a NEC3 project and gathering information from participants in such project. In chapter 4.3.3 this will be further developed.

3.6.2 Soundness of project team (SBW)

A temporary organization who is responsible for the completion of a complex building project which is managed by the NEC3 contract should have a 'sound' business. To handle the complexity, the team premise has to be based upon good business sense. Doloi, Iyer, & Sawhney (2011) and Doloi (2009) argue that sound project and SM enables the contractor to effectively manage and control uncertainties and enhances the feasibility to meet the key dates in a NEC3 project (p. 1251). To accomplish sound PM, SM and RM, Doloi et al. (2011) mention technical expertise, defect liability attitude, successful past projects & yearly turnover as the most relevant factors that provide for soundness. When looking at the NEC3 contract, Eggleston (2015) names the risk allocation procedures as important factors for the wellbeing of a project organization. Because this research revolves around RM and SM, the assumption is made that the expertise of the organization, the attitudes towards the liabilities, the close collaboration and the applied risk allocation policy are important factors in the establishment of a solid soundness of business/ stakeholder interaction. Other researchers see collaboration (a main criteria in the trust maturity model) during the project as a crucial element to reduce uncertainties and as a tool to enhance the project's soundness (Rafindadi et al., 2014; Sedita & Apa, 2015; Suprapto et al., 2015). Even though the soundness of business and workforce is classified under SM, it definitely is also part of RM.

3.6.3 Performance quality (QP) of the project team

Trust between the parties is a starting point for the achievement of success, but as mentioned before social relations and trust will be affected by the duration of temporary organizational forms. The planning of multiple stakeholders and the joint objectives are crucial element for the quality of a project. Objectives are aligned with regard to the procedures and the relationships. Quality relates to the satisfaction of the outcomes of the project. Xiong et al. (2014) argue that the process related satisfaction of a project refers to satisfaction with production quality, including project quality, safety and timely completion (p. 484). Doloi et al. (2011) names tender quality, tender timeliness, safety initiatives record, quality control and assurance programs and failure to perform safety requirements as important factors that define the quality of the performance (p. 691). The tender/procurement of a NEC3 project in the Netherlands is of high importance, especially because this is a new collaboration. The

procurement of such NEC3 projects must be comprehensive to enhance the future collaboration. When looking at the literature on NEC3 and the article of Doloi (2011), there are some similarities. Both articles state the importance of the safety, the quality of the tender and **the quality of the risk programs** for a good working relationship of the TMO. The quality of the control of risk programs in NEC3 will be monitored continuously and the joint objectives are the ground principles of the process. The project team (TMO) ensures continuous improvement of the risk register to enhance the quality of the project.

Summary

Reviewing the literature on NEC3, SM & RM there are some recurrent principles;
Early warning system, risk register, works information, liabilities concerning defects, common interests (joint goals) as part of NEC3**;** flexibility in handling risks and experience-based approach in tackling RM; recurrent interaction in TMO's, job performance, open communication and clearly defined job tasks (as the three most recurrent trust development factors in the observed articles) in SM. These recurrent principles all relate to trust, soundness, planning, and quality of a NEC3 project.

Different parts of RM and SM were studied in previous chapters. Not particularly how to tackle risks and problems regarding stakeholder relations, but to provide a better understanding of the importance of these project management components. Different factors were introduced that could enhance the success of a NEC3 building project. A key factor that underlies good RM is the ability to plan and control the whole project. Planning and controlling allows for good problem solving procedures which is one of the criteria named in the maturity model of Meng et al. (2011). The early warning system, the work specification and the flexibility of altering the risk register in NEC3 are tools that are used to manage risk in complex projects. To be able to have handle the process of these tools, the program of NEC3 (planning & control) has to be clear to all parties of the project team. SM is broadly elaborated by means of the trust, the soundness and the performance of TMO's.

Trust could be divided into several classification systems, however the system of Cheung et al (2011) represented the most trust development factors that were extracted from the observed literature Abderisak & Lindahl (2015) up to Suprapto et al. (2015) (in alphabetical order). Cheung et al. (2011) define trust as system-based trust, cognition-based trust and affect-based trust. Recurrent trust development factors in matrix 3.3 were the job performance of a project team, the open communication and clear role expectations/tasks. Open communication is also one of the criteria named in the maturity model of Meng (2011). The soundness has to do with the consistency of the organization. The soundness of an organization is a starting point of creating trust between the parties, but to establish a sound business expertise of the different stakeholders, taking responsibility for own actions, past performance and a proper allocation of risk are good principles to start with. This all together will stimulate a closer collaboration (collaboration and risk allocation are important criteria that determine the relationship between stakeholders (Meng et al. (2011).

Thirdly SM includes the quality of the performance of a TMO. The quality of the performance starts with the quality of the tender procedure. An optimal tender procedure enhances the

knowledge of the other involved stakeholders and makes it easier to set joint objectives. Another example is that NEC3 is a proponent of flexibility (also in risk programs) what increases the continuous improvement of a project. In this way the quality of the performance relates to the continuous improvement and objective criteria in the maturity model.

It may be said that the main criteria in the maturity model that measure the level of relationship between a client and a contractor and the factors mutual trust (SM), soundness of business (RM & SM), planning & control (RM) and quality performance (SM) have an interrelation with each other and together they shape the success of a NEC3 project.

3.7 Overall project success (OSN)

As stated in the previous section, the success of a NEC3 project is perceived to be dependent on the four factors Planning & Control, Trust, Soundness of Business and Quality Performance. However, project success is hardly to measure, because of the different perceptions of stakeholders in projects. Turner & Zolin (2012) argue that the perception of success by a temporary project's stakeholder often has little to do with the completion of a project on time, at cost and with desired quality. There are many projects that had many delays and had exceeded the budget but later were perceived to be very successful. On the other hand there are projects that were delivered on time and at cost but left the stakeholders dissatisfied because they failed to deliver benefits and quality. Other researchers conclude that the delivery of a project on time, at cost and with the desired quality are definitely important aspects of the success of a project (Akintoye & MacLeod, 1997; Davis, 2014; Doloi et al., 2011). Other articles (Koppenjan et al., 2011; Koops, Coman, Bosch-Rekveldt, & Hertogh, 2015) make a distinction in the success of a project between the success of the outcome or benefits of the project and success related to the controllability of the process up to project delivery.

The above named perceived attributes are outcomes of a successful project and are different from the attributes that are perceived as the influencing factors that lead to project success. All the criteria named in the maturity model relate to the trust between stakeholders, the soundness of the TMO, the planning & control of a project and the quality performance: Without trust the procurement becomes harder and the communication according to an 'open book' system becomes difficult; without soundness of business collaboration and allocation of risks is hard to establish; without planning & control problem solving becomes extremely difficult and without quality of the performance of a project continues improvement and honoring the objectives becomes harder. Researchers talk about the soundness of business as critical factors in the achievement of a successful project (Doloi et al., 2011; Hatush & Skitmore, 1997; Ling, Ke, Kumaraswamy, Asce, & Wang, 2013). Doloi et al. (2011) & Koppenjan et al. (2011) argue that planning and control are important factors that lead to the overall success of a project. The relationship quality and the quality of the performance of TMO's are important aspects for project success. The trust, the soundness of business, planning & control and the quality of performance as factors that influence the project success are underlying attributes in this article and the definition of these attributes according to researchers for further research is given in the glossary.

In the following table 3.9 these factors that influence the project success and the outcomes of projects success are summarized together with the observed articles that elaborate on these factors.

Table 3.9
Factors involved in the project success

Factors influencing project success	Author	Outcomes of project success	Author
Soundness of business and workforce	Ahmad et al. (2015) Doloi (2011)	Quality delivery	Turner & Zolin (2012)
Planning & Control	Ahmad et al. (2015) Doloi (2011), Hatush & Skitmore (1997)	On time, cost savings and on budget	Akintoye & MacLeod (1997), Davis (2014), Doloi (2011)
Quality performance	Doloi (2011), Ling et al. (2013) & Williams et al. (2013)	Benefits versus controllability of the process up to delivery	Koppenjan et al. (2011) Koops et al. (2015)
Mutual trust	All most every article	Good coordination	Hanish & Wald (2014)

The four factors on the left side have an influence on the project success of a project. This concept of project success is perceived to be dependent on the others.

3.8 Discussion

The literature review consists of four main parts: exploring the British NEC3 contract, with a focus on the contract's project management tools; exploring common used RM tools in the past decade, exploring SM with a special focus on trust, sound business and performance and the common perceived project success. The chapters on RM and SM were meant to support further research when exploring the project success of a NEC3 project.

A matrix was utilized in this paper to get a better view of what instruments construction companies use to set up RM and also classification systems of risks are examined. These matrices form a basis for the understanding of how construction companies try to understand the likelihood of problems in every unique project.
When looking at the reviewed literature, semi-structured interviews were conducted by Crespin-Mazet et al. (2015), Gehner et al. (2006), Guo et al. (2014), Lehtiranta (2014a), Os et al. (2015), to identify the perceived risks by project members in a construction project. These articles help to understand why certain risks (for example external of internal risks) are of more importance in a certain project than others.

With regard to SM, trust is simply indispensable for short term strategic relationships like TMO's. The relationship between contract and trust is uncertain in a way that trust in some cases seems to precede contract while at others instances contract precedes trust (Khan et al., 2011). NEC3 attaches great importance to this concept.
In-depth interviews were used by Chan et al. (2011), Cheung et al. (2011), Laan et al. (2011) & Poppo et al. (2008) to find out how and why trust between project partners develop over time. In this research matrix 3.4 was structured including different trust models (classifications of various forms of trust according to authors), to look for the inclusive trust model that included the most trust development factors of the structured matrix 3.4. This comparison showed that Cheung et al. (2011) was the most comprehensive trust model.

Factor Analysis within SEM is also often used to measure psychological concepts as trust between different stakeholders in construction projects (Chow et al., 2012; Gad & Schane, 2014; Huai et al., 2012; Ning & Ling, 2015; Pinto et al., 2009; Poppo et al., 2008; Turner & Zolin, 2012; Xiong et al., 2015), but also to measure the important risk factors in mitigating risks in construction according to experts (Chan et al., 2012).

Articles concerning both concepts of RM & SM like Guo et al. (2014) used case studies to get a better view of the relationship between project organizations and project RM, while Taillandier et al. (2015) used a multi-agent model to evaluate risk impact for each stakeholder and for the whole unique project.
Turner & Zolin (2012) used a online survey tool (questionnaire) to map multiple perspectives by multiple stakeholders in specific timeframes to evaluate project performance, where Caniato, Vaccari, Visvanathan, & Zurbrügg (2014) and Heravi, Coffey, & Trigunarsyah (2015) used interviews with stakeholders to prioritize characteristics and relationships which they considered important for project success. Aryee et al. (2015), Doloi et al. (2011), Qureshi & Kang (2014), Xiong et al. (2014) used SEM for assessing the performance of a project team on project success.

3.9 Conclusion & future research

The analysis and conclusions of this research are intended to provide suggestions for the improvement of conceptual knowledge by addressing gaps. This research tried to get a better understanding of the NEC3 contract, RM (with a focus on planning & control) in de construction industry and SM with particular focus on trust development, soundness of business and performance of TMO's) and to create awareness on the importance of the interrelationship between these aspects; risk & SM and the potential contribution of NEC3 to such multi organizational integrated projects.

The chapter on the NEC3 contract explored many important clauses (some are common used project management tools and some are innovatory). With this chapter the first research question is answered. Paragraph 3.4.4 served to give an answer to research question 2. The clauses could be used in further research to examine perceived importance of these clauses by Dutch experts in the construction industry.

Chapter 3.5 Risk management (RM) and chapter 3.6 Stakeholder management (SM) served for answering research questions 3 Setting up good RM in complex construction projects and 4 The development & the role of trust between different stakeholders in complex construction projects as the source for success factors.

Trust is important in contracting as a means to suppress the practice of opportunism arising from inseparable risk and information asymmetries in construction projects (Chow et al., 2012). Although many researchers tried to tackle trust in construction projects, developing trust remains a form of verbal expression of agreement. In general, trust is seen as an important factor for the overall success of a projects.
Some articles are contradictory in the context of success factors of a project. In section 3.7 it was mentioned that Turner & Zolin (2012) argue that the success of a project has little to do with costs, quality and time, while Akintoye & MacLeod (1997), Davis (2014), Doloi et al. (2011) conclude that the delivery of a project on time, at cost and with the desired quality are definitely important aspects of the success of a project. Further research should examine the importance of these three factors in the NEC3 contract. This could be accomplished by questioning the perceptions of experts in the Netherlands. Mentioned factors that lead to project success are planning & control, quality performance of a TMO and soundness of business. These aspects will be used in further research.

Mok et al. (2014) argue that existing literature have neglected national cultural variances and attempted to use universal SM & RM approaches for construction projects. Future research should not neglect these difference. When the differences are taken into account, the results will be more beneficial. NEC3 has his own way of handling these concepts. Looking at the NEC3 contract, literature showed that the influence of certain contract types on the relation between client/contractor is often investigated, but that the relation to the project-specific contexts is also of high importance (Suprapto et al., 2014). This will be investigated by introducing a specific NEC3 project.

Now that the important aspects of NEC3, the used RM tools in the construction industry and in NEC3 and the most relevant SM tools for NEC3 are mapped, further research should integrate these core principles of this research in a model:

Evaluating the relevance of NEC3 on the collaboration between stakeholders in a temporary multi organization (project specific), looking at the risk allocation and trust clauses in the contract.

When assessing all the mentioned gaps in the research area of RM (planning & control) & SM (trust, soundness & performance) in multi-organizations, the most important research subjects for further research are:

- ❖ Further investigate the contract type influencing project-specific contexts in the Netherlands compared to Great Britain;
- ❖ Model the interrelation between RM (planning and control), SM (trust, soundness & performance) in combination with NEC3 to see how NEC3 leads to project success.

These aspects will form the basis of the research model. The goal is to evaluate the contribution of the NEC3 collaboration on the overall project success. The most common used methods to map RM, trust and relationships between stakeholders are conducting semi-structured interviews, questionnaires and SEM. The latter is a suitable method to test hypotheses and inter correlations between different factors (including psychological factors such as trust) resulting in project success. This method is often supported by questionnaires.

An important implication for further research is the lack of information on NEC3 in the Dutch construction industry. Also the British legal system is very different from the Dutch system. The basis of the British legal system lies in the jurisprudence, where in the Netherlands everything is recorded in law. Judges in the UK have made decisions over the centuries and a logically coherent system is built up slowly with it. It is not true that the written law is necessarily of a higher order than the common sense or the morality of the judge. Therefore, a proposition that the NEC3 collaboration will work in the Dutch environment should be handled carefully. One way to examine this difference is to use a Dutch case study of the NEC3 contract (there is only one example). For this reason a maturity model on the relationship between a client and contractor was examined in chapter 3.6. Further research should revise this existing maturity model so it will be applicable for measuring the trust in the Dutch case study of NEC3. Criteria in this model could support the important factors that rose up in the literature review: Trust, Sound Business, Planning & Control and Quality performance. All these factors represent clauses of the contract. It is of high importance that knowledge of Dutch experts is gathered to validate certain assumptions on the implementation of the British contract in the Dutch construction industry. The final goal is to get insight in the positive impacts NEC3 could have for HEVO.

4 Research Model

4.1 Abstract

Project success is a widely discussed subject, both the determination and the achievement (Koops et al., 2015). As been stated in the literature review and different observed literature, the establishment of trust has been identified as a critical factor that facilitates partnering success (Wong & Cheung, 2005) and together with planning and control, a sound business and the performance Doloi (2011) argues that the chance of success increases. An important guidance of the NEC3 family is mutual trust. However, this ambiguous concept still remains hard to measure. This research aims to get a better understanding of the added value of NEC3 in the field of RM & SM when looking at the overall project success of a TMO (Temporary Multi Organization). While clients of a NEC3 project strive hard to make the best decisions in selecting the right contractor in a tender, a clear understanding of the underlying factors associated with the collaboration of NEC3 in the context of achieving successful project outcomes is critical (Doloi et al., 2011). This research reports the use of **SEM** because this method is able to test different hypotheses containing different aspects of the contract and tries to understand these aspects and their links to the NEC3 performance on a project. The important clauses stated in the contract will be assessed by experts in the construction field by means of a survey. The goal of this research is to evaluate the expert's opinion on the contribution of the British contract NEC3 in the Dutch construction industry. Also in the review the question how to interpret success emerged what resulted in the second goal to find out how Dutch construction stakeholders view the success factors of a complex construction project.

Keywords: Case study NEC3, maturity model on trust, factor analysis, SEM

4.2 Introduction

The foundation of the research area is presented in the literature review, after which the next step in the research can initiate. This part is focused on the perceptions of different stakeholders in the construction industry on the added value of NEC3 when looking at complex temporary projects involving many interactions and problem solving procedures. To get a better understanding of the NEC3 contract with regard to the key concepts of this research namely RM (planning & control) and SM (trust, sound business and performance), a case study of a NEC3 project is presented first. After the case study, the core goal is to gather data from interviews and a questionnaire, to learn the practical view of stakeholders ranging from project managers to architects in a project. To get a better view and to be able to ask the right and more direct questions, the questions are formulated in accordance to the highlighted aspects in the contract. When the expert in the construction industry are selected, the script for the questionnaire can be made and the data gathering can begin. This ultimately leads to the evaluation of the remaining sub questions 5 & 6.

When the sub questions are answered and the hypotheses are tested and validated, this chapter can be closed with the main research question:

How does NEC3 improve the interaction between multiple stakeholders and the problem solving procedure in complex building projects?

4.3 Method

4.3.1 Research Process Design

There are basis structures for carrying out fieldwork in the management sector. One is the regulative cycle, which is focused on problem solving and the other is focused on verifying hypotheses and producing scientific knowledge (Aken, Berends, & Bij, 2012). This research focuses on the steps of the empirical cycle. The first step observation: the collection and organisation of empirical facts by means of the literature study will be carried out for forming hypothesis. The second step is formulating hypotheses on the basis of the facts, called induction. Deducting consequences of hypotheses as testable predictions is the third step in the process. The predictions will be tested and evaluated.
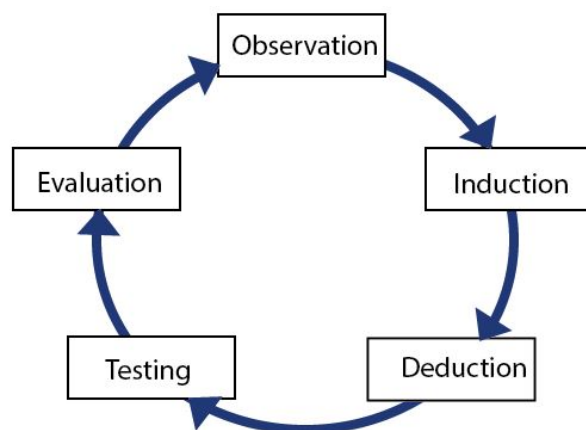
Figure 4.1 Empirical cycle (Groot, 1969)

The literature review showed that the factor analysis within SEM is a common used tool to identify individual factors which could represent the relationships of many interrelated variables. This could help to understand the different factors involved in the collaboration of NEC3. The case study will be a supporting tool for the factor analysis. SEM is chosen over other techniques like multi agent modelling because the interest in SEM usually focuses on latent factors as abstract psychological variables like 'intelligence' or 'attitude'. In this research trust plays an important part which is considered a difficult psychological concept in sub paragraph 3.6.1.

There are two types of factor analysis: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). CFA evaluates deductive hypotheses and is largely driven by theory. The numbers of factors are hypothesized in advance, whether or not these factors are correlated and which items load onto and reflect which factors. It is a first step to assess a hypothesized model. EFA identifies interrelationships among items and group items that are part of unified concepts. In this case there are no prior assumptions about relationships among these items, what resulted in the use of CFA. The empirical cycle used for SEM is presented in figure 4.1 and is specified as follows:

Observation is conducted by means of the literature review and a case study. Formulating hypotheses (induction) with the help of literature and the case study is a part of SEM. As mentioned before, CFA's objective is to test whether the data fits a hypothesized measurement model. A measurement model specifies relationships among observed variables underlying the latent factors. The structural model specifies relationships among the latent as adopted in theory. The deduction of consequences is performed by this measurement model. Testing and evaluation of the hypotheses will be conducted by the CFA.

To complement the knowledge gained from the literature and to get a better view of the realistic operation of the contract to set up a good SEM model, first an actual implementation (case study) of the NEC3 is studied.

4.3.2 Structure of the research method

The research model consists of two parts: a case study on a NEC3 project with the help of an adjusted maturity model and second the SEM model.
The case study on NEC3 is elaborated before the SEM model because the results of the case study are input for the questionnaire that is part of SEM. An important note that should be made is that normally a case study is presented after a structured model to test the model, but in the case of this research the case study validates the theoretical information on NEC3 and serves as supporting tool for the presented items in the SEM questionnaire.

At first the only available Dutch NEC3 project is elaborated in paragraph 4.3.3. This case study concerns the construction of the International Criminal Court (ICC) in The Hague. This project is assessed by an adjusted 'trust maturity model'. The paragraph discusses the NEC3 contract in general and the NEC3 contract in the context of the ICC project.

When the NEC3 contract is discussed on its positive and negative characteristics, the SEM analysis will initiate. SEM is a family of statistical methods designed to test a theoretical or conceptual model. This research uses factor analysis within the SEM analysis to assess unobservable 'latent' concepts (factors). This research employs SEM because this method is commonly justified in social sciences (and this research uses the factor Trust): it has the ability to impute relations between unobserved and observable variables (Schumacker & Lomax, 2010). The term refers to two things: a **measurement model** defines latent variables using one or more observed variables and a **structural regression model** links latent variables together. The links between factors of a structural equation model may be estimated through involved approaches such as those employed in the statistical tool SPSS AMOS. However, SEM does not only consist of making a measurement model and a structural model. Data screening is needed to validate the available data, because the data has to meet a lot of requirements to fit SEM (AMOS cannot even run a model when certain requirements are not met).
The SEM analysis will start after paragraph 4.3.3 Case study, and the data will be evaluated in paragraph 4.3.5 Data screening, paragraph 4.3.6 Exploratory factor analysis and paragraph 4.3.7 Confirmatory factor analysis to see if a SEM analysis in AMOS is even possible. When the data fits the requirements, the structural model will be structured in paragraph 4.3.8.

4.3.3 Case study on NEC3

The target contract of NEC3 is concerned with RM (RM) by means of maintaining an early warning register and the risk register that are controlled by the project manager and SM by means of the 'open book' system, clause §10.1 in 'General' concerning mutual trust and the pain/gain sharing mechanism. This part tries to understand how these fine words actual work in practice. All the aspects named in NEC3 build upon the ground principles of collaboration and trust in each other. In order to understand the principles of the contract an existing maturity model is presented in the literature review that measures the level of relation between a client and a contractor during a project. This model could help to address the positive and negative aspects of the contract by assessing several clauses named in the contract. The criteria named in the maturity model will be connected to the five latent factors in the final SEM model (continuation of 'Concluding remarks'). The relationship levels introduced by Meng et al. (2011) will have to be restructured to make it more applicable for this research. Level 1 which is named 'Price competition' in the relationship model could be renamed 'Low trust' in de restructured own Trust model. The thesis of Cheung (2015) will be a guiding tool for the adjustments, because Cheung did also research into the trust between the client and the contractor.

Level 2 'Quality competition' will be renamed 'sufficient trust', level 3 'Project partnering' in 'strong trust' and 'Strategic partnering in 'complete trust'. To give an example, the UAV –GC is assessed as a combination of 'Price competition' and 'Quality competition' by Veldhuizen (2015) what will suggest a low/sufficient trust level.

The original maturity model on the relationship between a client and contractor has eight main criteria shown in table 3.8 in the literature review namely procurement, objectives, trust, collaboration, communication, problem solving, risk allocation and continuous improvement. Some criteria should be revised for this research, because **trust** will become the assessment tool in the horizontal direction in the restructured model for all the criteria instead of the relationship. Adjustments that will improve the applicability of the trust maturity model for this research are represented in the following tables with a short explanation of every change, i.e. procurement will be renamed trust during procurement and collaboration will be renamed collaboration during project (to capture the temporary state) and so on.

Tabel 4.0 Transformation of relationship maturity model in trust maturity model

1 Procurement	Selection criteria	The lowest price	Cost and quality	Multi-criteria from short-term perspective	Multi-criteria from long-term perspective
	Procurement route	Single-stage tendering	Two-stage tendering	Negotiation or tendering	Direct negotiation
	Form of contract	JCT	JCT/NEC	NEC/PPC 2000/JCT CE	MEC/TPC 2005/JCT CE/ Bespoke contract

1 Trust during Procurement	Selection criteria	The lowest price	Cost and quality	Multi-criteria from short-term perspective	Multi-criteria from long-term perspective
	Selection criteria 2	No stated trust component in the selection for party	Seek party with good reputation	Seek party with great competence	Seek party with good track record, reputation and competence

1) Procurement -> Trust during procurement:
'Procurement route' is replaced by selection criteria 2 which identifies the detailing of the track record. The form of contract is been left out, because the restructured model will assess the specific NEC3 contract.

2 Objectives	Objectives alignment	Only self-objectives	Mainly self-objectives	Mutual objectives in a project	Mutual objectives in the long-term
	Benefits	Win-Lose	Win-Partial Win	Win-Win in a single project	Win-Win in the long-term
	Continuity of work	No continuity of work	Prospect of future work through tendering	Preferred suppliers	Guarantee for future work

2 Objectives	(Joint) goal setting	Only self-objectives	Mainly self-objectives	Mutual objectives in a project	Mutual objectives in the long-term
	Benefits	Win-Lose	Win-Partial Win	Win-Win in a single project	Win-Win in the long-term

2) Objectives:
The sub criteria Objectives alignment will be renamed goal setting. The sub criteria 'Continuity of work' is been left out because the assessment of the NEC3 contract is on the basis of one project.

3 Collaboration	Working relationship	Confrontation or arm's length	Limited cooperation	Collaboration	Close collaboration
	Mutual help	No support for the weaker	Support only with the issues related to self-interest	Often support for a weak partner	Always support for a weak partner
	Culture	Mutual blame	Self defence	Abandon of blame culture	Problem solving focused culture

3 Collaboration during project	Confidence in others' behavior	Little confidence	Some confidence	High confidence	Complete confidence
	Culture	Mutual blame	Self defence	Abandon of blame culture	Problem solving focused culture

3) Collaboration -> collaboration during project:
The 'working relationship' and 'mutual help' are clustered together in 'Confidence in others' behavior. When the confidence is high parties are willing to help and to cooperate.

4 Communication	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly
	Cost data transparency	No cost transparency	Little cost transparency	Open book costing between two parties	Open book costing throughout the whole chain
	Sharing learning	No sharing learning and innovation	Little sharing learning and innovation	Sharing learning and innovation	Continuous sharing learning and innovation

4 Communication	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly
	Communication system	No communication strategy implemented	Project communication strategy with agreed system	Communication strategy at beginning of project, communication system is implemented	Communication system provides open book system, transparency, IT based system provide for information exchange

4) Communication:
‘Cost data transparency’ and ‘sharing learning’ are clustered together in ‘Communication system’. This includes a transparent SharePoint with an open book system.

5 Problem solving	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain
	Avoidance of recurrence	Problems often recur	Sometimes problems recur	Few problems are repeated	Rare problems are repeated
	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level

5 Problem solving	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain
	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level
	Procedures/system	Too many complex intersecting procedures	Procedures are very complex	Complex procedures are managed throughout manageable system	Problem solving straight forward with a clear problem-solving system

5) Problem solving:
‘Avoidance of recurrence’ is renamed ‘procedures/system’, to be able to assess the problem solving procedure (in the case of NEC3 compensation events).

6 Risk allocation	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term
	Balance of risk and reward	No rewards for the party taking the risk	Some rewards for the party taking the risk	Often appropriate rewards for the party taking the risk	Always appropriate rewards for the party taking the risk

6 Risk allocation	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term

6) Risk allocation:
‘Balance of risk and reward’ is eliminated, because the observed literature did not mention a reward system regarding the allocation of risks.

7 Continuous improvement	Joint effort	No joint effort for improvement	Limited joint effort for improvement	Joint effort for better ways of working	Continuous effort for better ways of working
	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; Irregular but formal feedback	Common measures; Regular and formal feedback in a project	Common measures; Formal, regular and continuous feedback
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives

7 Continuous improvement	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; Irregular but formal feedback	Common measures; Regular and formal feedback in a project	Common measures; Formal, regular and continuous feedback
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives

7) Continuous improvement:
Joint effort is placed within Objectives.

The relationship maturity model is now revised in an own trust maturity model with seven criteria (blue boxes). In the following section this model will be used to assess the NEC3 contract in two ways: first the contract of NEC3 in **general** and second the NEC3 contract applied on a **specific project**.

The seven criteria in the maturity model are no coincidental concepts as concluded in the literature review. The criteria will be linked to relevant latent variables for the further analysis.

Maturity model focused on general NEC3 literature

To assess the NEC3 contract by means of the revised trust maturity model, the book of Brian Eggleston (2015) ''a commentary on the NEC3 contract'' is used in combination with literature that was available on the Dutch construction project of the International Criminal Court (ICC) in The Hague which is executed with the NEC3 ECC-C contract (NEC, 2014).

As shown on the previous pages, the maturity model of Meng et al. (2011) on relationship levels between client and contractor is transformed into a trust level model (with help of Cheung (2015)). The trust level within a NEC3 project is measured according to the seven criteria obtained in the previous paragraph (highlighted in blue) and fifteen sub criteria. These criteria are adapted from the existing maturity model of Meng and are separate from the five factors 'Trust, Soundness of Business, Plannign & Control, Quality Performance and Overall Success of NEC3' project that relate to the clauses. However in the end, the relation between these criteria and the factors could be detected because there are a lot of similarities. NEC3 will be assessed two times by means of the adapted trust maturity model like mentioned before: first the general NEC3 contract and second the NEC3 contract applied to the ICC project in the Netherlands. The general trust levels of the NEC3 contract (based on Eggleston, 2015) are depicted as the blue highlighted compartments in table 4.2 which represents a certain level score (presented in the last column of the table).

Table 4.1
General information on NEC3 contracts

	General information NEC3 Engineering & Construction Contract – option C
Year	Updated NEC3 suit version April 2013
Components	Core clauses, main option clauses, the optional secondary clauses, dispute option clauses, contract data format & schedule of cost components
Origin	British common law
Type	International contract – applicable in all countries because it is adjusted for the prevailing law
Core concepts	Flexibility, clarity (open book), simplicity (plain language)
Applicable	Complex D&B and E&C

Table 4.2
Transformed maturity model of relationship into trust

Main criteria	Sub criteria	Level 1: Low trust	Level 2: Sufficient trust	Level 3: Strong trust	Level 4: Complete trust	Score
1 Trust during Procurement Trust	Selection criteria	The lowest price	Cost and quality	Multi-criteria from short-term perspective	Multi-criteria from long-term perspective	3
	Selection criteria 2	No stated trust component in the selection for party	Seek party with good reputation	Seek party with great competence	Seek party with good track record, reputation and competence	1
2 Objectives Quality performance	(Joint) goal setting	Only self-objectives	Mainly self-objectives	Mutual objectives in a project	Mutual objectives in the long-term	3
	Benefits	Win-Lose	Win-Partial Win	Win-Win in a single project	Win-Win in the long-term	2.5
3 Collaboration during project Soundness of Business & Workforce	Confidence in others' behavior	Little confidence	Some confidence	High confidence	Complete confidence	3
	Culture	Mutual blame	Self defence	Abandon of blame culture	Problem solving focused culture	3
4 Communication Trust	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly	4
	Communication system	No communication strategy implemented	Project communication strategy with agreed system	Communication strategy at beginning of project, communication system is implemented	Communication system provides transparency, IT based system provide for information exchange	2
5 Problem solving Planning & Control	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain	4
	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level	3
	Procedures/system	Too many complex intersecting procedures	Procedures are very complex	Complex procedures are managed throughout manageable system	Problem solving straight forward with a clear problem-solving system	2
6 Risk allocation Soundness of Business & Workforce	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing	3
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term	2.5
7 Continuous improvement Quality of performance	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; Irregular but formal feedback	Common measures; Regular and formal feedback in a project	Common measures; Formal, regular and continuous feedback	3
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives	4
				Average trust level score		2.87

Note: Adapted from '' Research into the influence of mutual trust between the Client and the Contractor on the efficiency and the effectiveness of the change management process for complex D&B infrastructure projects using the UAC-IC 2005'', by L. Cheung, 2015, *Thesis,* p. 158.

The NEC3 contract is assessed by means of different literature (Brink Groep, 2015; Broom, 2015; Eggleston, 2015; Evans, 2013; Watermeyer, 2009, 2015). When the levels are assessed and the scores are examined, the mean of 2.87 on a scale from 1 to 4 is calculated (shown in the last column of table 4.2. This insinuates a strong trust level but in some cases (for example the risk allocation) a sufficient trust level is present. In the next section the specific trust level (highlighted in blue) of NEC3 during the ICC project is measured based on assumptions and verifications gained by the experts. The difference between the trust levels will be evaluated in 'Discussion of trust in NEC3 relating to the seven main criteria'.

Maturity model focused on ICC

To validate the literature on NEC3 and the ICC project, personal contact with three experts in the field of NEC3 Contract Management was performed. These experts did research into the British contract for Dutch purposes. In Appendix B questions are bundled that were asked to these experts (an alternative form of semi-structured interview, allowing new ideas to be brought up during the conversations). These questions relate to five of the seven criteria of Meng et al. (2011). 'Collaboration during project' and 'Continuous improvement' are being left out in the asked questions because all three experts were not involved in the proceedings of the NEC3 project. However, these two criteria are still present in the maturity model showed below to be able to make a comparison between the trust scores of the general information on the NEC3 contract and the specific NEC3 project. Information about these two criteria is gained through the literature on the ICC.

Further, a distinction in the questions was made between the experts involved in a NEC3 project and the expert who did research into the contract to avoid questions that did not apply to the answerer. Next to the format of the questions, the conversations are also included in Appendix B. This appendix shows that the three conversations were different in the asked questions (some questions were made bleary that did not apply to the respondent). Table 4.3 present the general information on the ICC project and table 4.4 on the next page present the trust levels in the ICC project (highlighted in blue).

Table 4.3
General information ICC (NEC, 2014), retrieved from www.neccontract.com

	General information ICC The Hague
Year	2012-2015 (2016?)
Value	€147 million
Used contract	NEC3 ECC option C (Target Contract with Activity Schedule)
Client	International Criminal Court
Contractor	Visser & Smit Bouw and Boele & van Eesteren (Courtys)
Project manager and advisor	Brink Groep

Table 4.4
Trust levels in ICC project. Criteria are linked to success factors that appeared in literature review

Main criteria	Sub criteria	Level 1: Price competition (low trust)	Level 2: Quality competition (Sufficient trust)	Level 3: Project partnering (Strong trust)	Level 4: Strategic partnering/ Alliance (Complete trust)	SCORE
1 Trust during Procurement Trust	Selection criteria	The lowest price	Cost and quality	Multi-criteria from short-term perspective	Multi-criteria from long-term perspective	3
	Selection criteria 2	No stated trust component in the selection for party	Seek party with good reputation	Seek party with great competence	Seek party with good track record, reputation and competence	4
2 Objectives Quality performance	(Joint) goal setting	Only self-objectives	Mainly self-objectives	Mutual objectives in a project	Mutual objectives in the long-term	3
	Benefits	Win-Lose	Win-Partial Win	Win-Win in a single project	Win-Win in the long-term	2.5
3 Collaboration during project Soundness of Business & Workforce	Confidence in others' behavior	Little confidence	Some confidence	High confidence	Complete confidence	3
	Culture	Mutual blame	Self defence	Abandon of blame culture	Problem solving focused culture	4
4 Communication Trust	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly	4
	Communication system	No communication strategy implemented	Project communication strategy with agreed system	Communication strategy at beginning of project, communication system is implemented during project	Communication system provides transparency, IT based system provide for information exchange	4
5 Problem solving Planning & Control	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain	4
	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level	3
	Procedures/system	Too many complex intersecting procedures	Procedures are very complex	Complex procedures are managed throughout manageable system	Problem solving straight forward with a clear problem-solving system	2
6 Risk allocation Soundness of Business & Workforce	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing	3
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term	3
7 Continuous improvement Quality of performance	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; Irregular but formal feedback	Common measures; Regular and formal feedback in a project	Common measures; Formal, regular and continuous feedback	3
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives	4
				Average trust level score		3.3

Looking at table 4.4, the average score of the ICC project is a trust level of 3.3. Criteria that are assessed differently in relation to the general trust level in the NEC3 contract (2.87) are 'Trust during procurement selection criteria 2', 'Collaboration during project', 'Communication system' & 'Risk allocation principle'. The cause for the difference between the scored trust levels of the contract in general and the contract applied to ICC is elaborated in the next section.

The criteria 1 to 7 are related to the four underlying factors Trust, Soundness of Business, Planning & Control and Quality Performance.

<u>Discussion of trust in NEC3 relating to the seven main criteria</u>

Important aspects within the NEC3 that could enhance trust in a TMO are the mutual early warning for risks, the risk reduction meeting, the open book requirement, the gain/pain mechanism & clause 10.1 stating that the stakeholders should act in a spirit of mutual trust and co-operation. The aspects in the NEC3 contract that could cause distrust (scores NEC3 below level 3) are the sanctions of the Compensation Event time bars, the absence of a communication system and no demonstrated trust aspects in the procurement stage. Below the scores of the NEC3 contract below 3 are examined.

1) Trust during procurement   TRUST

The literature on the contract does not state to seek the party with a good reputation, a good track record and competence of RM. This aspect has to do with the fact that procurement law is national law and the NEC3 is an international contract. But these measurements are unwritten rules for every contracting entity.

Verification ICC

Brink Groep guided the tender of the ICC. When option C target contract is chosen the project is not tendered according to the lowest price, companies are asked to come up with a competitive price to get to most value for money. Many companies applied for the project and eventually five companies remained who had a chance to execute the project. A preselection was conducted by means of financial records, past performance (reputation), competence. In the next stage of the tender a dialogue was held (with all the candidates but also face-to-face) to openly evaluate all candidates. In this period a certain trust level was generated. By means of 'gunningscriteria' (substantive criteria) the best suited company was selected (Beaujean on behalf of Brink Groep, personal communication, October 29, 2015)

2) Objectives   QUALITY PERFORMANCE

The win-partial win/ win-win in a single project has to do with the fact that NEC3 avoids the usual lengthy statement of the contractor's general obligations and responsibilities and relies on a single short sentence in §20.1 of 'Contractor's main responsibilities' stating that the contractor provides the works following the Works information. As mentioned in the literature review 3.4.4, it is not clear if the works have to be fit for purpose. When the client choses option X15 which limits the liability of the contractor for his design to reasonable skills, this is a downturn to the traditional British contract rather than the Design & Build contract (traditional contracts require a reasonable skill and care for the design). There are mutual objectives in the NEC3 contract, but clause 14.3 states that the project manager may give an instruction to the contractor which changes the works information. It should not be that simple because the project manager cannot have an unfettered power to change the works information and thereby change the obligations of the contractor (Eggleston, 2015, p. 101). NEC3 lacks an express obligation to perform variations. This clause has to be seen also as the contractor's obligation to perform variations next to the originally defined obligations. Because this aspect is unclear, this criteria of objectives has scored a 2.5 for the trust level.

Verification ICC

Looking at the International Criminal Court, the option X15 was not included in the contract. This means that Courtys had to execute the design on the basis of fitness for purpose. Beajean (personal communication, October 29, 2015) states that this could be interpret as 'performance obligation' which is mostly the case in the current UAV-GC where reasonable skill and care could be interpret as 'effort obligation' which is the case in DNR (relationship client and architect) This is plausible because the client, in this case the ICC itself, carries less risks.

de Kleijnen (personal communication, November 3, 2015) argues that option X15 will be included in the contract when the Client itself has employed own architects. In this case the architect has more freedom to create his own design and the Client only sets certain criteria and has full confidence in the architect.

3) Collaboration during projects (culture)   SOUNDNESS OF BUSINESS AND WORKFORCE

An important difference between the Dutch and the British contractors is that in England namely investors with money who do not have own staff hire other subcontractors as construction workers etc. Dutch contracting companies such as Heijmans, have their own personnel. This has consequences for the allocation (shifting) of the risk and thus the manner of collaboration during the project.

Verification ICC

Even if there are many stakeholders and subcontractors involved in the project, because of the 'open book' system the contract ensures open discussions, interrelations between the stakeholders and interests in the works of others. The setup of the contract ensures a collaborative meeting including all parties to estimate all the risks involved in the project. The current state of the Dutch way of working is that in most cases the contractor chooses his own subcontractors. In NEC3 projects the client also determines the subcontractors (Veldhuizen, personal communication November 12th, 2015)

4) Communication   TRUST

Eggleston (2015, p. 96) states that the contract does set out rules to carry out communication (instructions, certificates, submissions, proposals, records, acceptances, notifications and replies). However, literature on NEC3 does not state that there is a specific transparent communication system. The NEC3 procedures are comprehensive and contain requirements for formal communication such as instructions and notifications (period of reply, extending the period, withholding an acceptance etc.). According to Cheung (20152), Eggleston (2015), Evans (2013) an increased administrative burden will be created when these communication rules and procedures are strictly followed. Every notification has to be given separately and in writing.

Verification ICC

Core clause § 13.1 in chapter 1 'General' states that the stakeholders should communicate in a form which can be read, copied and recorded (Eggleston, 2015, p. 96). This suggest that it should be in writing. Communication between the stakeholders involves instructions, certificates, submissions, proposals, records, acceptances, notifications and replies. Decisions are not included in this list but this is an unwritten rule that is should be included in the clause.

The book of Eggleston implies that there is no integrated communication system for these documents/exchanges. However, the ICC used a SharePoint to document all the relevant data of the project. Also informal contact to evaluate certain decisions was present (Brink Groep, 2014)

Dutch construction companies (who work according to the reasonableness & fairness principle) are not used to communicate everything according to formal procedures. NEC3 (which works according to the Anglo-Saxon model) states that every alterations should be notified by paper and meetings. In the Dutch environment planning is most important and contract management is a less familiar area.

de Kleijnen (personal communication, November 3, 2015) formulated a great advantages of NEC3 by means of the more objective formulated system communication. What is meant with this is that in building projects, every company works with his own systems. Some contracts allow for situations that a project manager could use his own project management system that could constrain the contractor in his work. NEC3 formulates the correspondence of the various systems more objectively.

5) Problem solving	PLANNING & CONTROL

§16.1 in 'General' of the contract places an obligation on both the project manager and the contractor to give an early warning notice to the other as soon as either becomes aware of any matters which could result in a delay in meeting a key date, delay completion, increase the total price or impair the performance of the works in use. This was already explained in the literature review, with an addition that §63.5 relates to the sanction on the contractor for failing to give a required early warning:

The clause states the sanction as follows: ''*If the project manager has notified the contractor of his decision that the contractor did not give an early warning which an experienced contractor could have given, the event is assessed as if the contractor had given an early warning* (Eggleston, 2015)''

This statement is questionable because it suggests that the sanction is favorable for the contractor and that is does not matter whether the contractor gave an early warning or not. §63.5 in 'Compensation Events' sets out that the event is assessed as if the contractor had given an early warning so that the cost and time savings which the parties could have gained due to an early warning can be determined (the contractor is liable for the lost cost and time savings, stated in a sub clause)(Eggleston, 2015, p. 272). Different experts (Eggleston, 2015; Lloyd, 2008) argue that the clause should contain true sanctions with no doubt about their nature and extent. A client cannot be sure of the lost costs and time savings because determining the time when the early warning should have been given is difficult.

Also Compensation events (CE) in the NEC3 contract are very complex issues. The procedure is set out in six clauses namely §60-65. CE's deal with claims from the contractor, but most comments related to claims are related to the contractor's time bar, the sanction and the considered acceptance in the procedure and whether these are reasonable.

Clause 64.1 deals with the assessment of the contractor's quotations by the project manager and the possibility to draft his own quotation for CE (Eggleston, 2015, p. 263). Cheung (2015) argues that the project manager has a dual role in the compensation event procedures,

because the project manager is the representative of the client and has a crucial role in the compensation event procedure. It poses questions whether the project manager is able to act fairly and impartially when assessing CE's (the contract does not state this ambiguity. When assessing compensation events and payments the project manager must act as a certifier (act impartially between the contractor and the client) and in all other cases as the agent of the client, according to (Evans, 2013; Lloyd, 2008). This conclusion is arguable because the common law in England understands this conclusion, other countries that are not based on common law would have more difficulties in understanding the binary role of the project manager (L. Cheung, 2015, p. 48).

Verification ICC

First of all an important change for the Dutch construction industry is the perceived vulnerable position regarding notifying certain risks. In the conservative building environment the contractor perceives the notification of a risk as an inability of his own work (Veldhuizen, personal communication, November 12th 2015). NEC3 sees the capability of giving warnings of certain risks not as inabilities but as a high quality. Being aware of own risks is seen as a good control measure of the project.

Clause §31.3 in 'Time' deals with the programme/planning of the project (Eggleston, 2015, p. 156). NEC3 relies on there being an accepted programme. If there is no identified programme in the beginning, the contractor has to submit a first program for acceptance within the stated period. Not accepting the program by the project manager could mean that the plan is not practicable, certain information is not shown, the plan is not realistically or the program does not comply with the works information. When the project manager withholds acceptance for a reason other than the above mentioned reasons a compensation event is mostly assumed. In the case of the ICC; when the client or the project manager takes account for changes, it is assumed that the contractor can revert to the compensation events. But due to the detailed program and '**open book**' system, the client has an insight in the critical path of a project. When a certain change in the program doesn't mean a change in the critical path the contractor is not entitled for compensation.

The planning and control of NEC3 is complex because of the program management system. The contractor should update the program periodically. Any established program is a contract document. This is more binding in meeting the program, both by project manager and contractor. Failure to comply with the programme is a breach of contract and has financial consequences.

6) Risk allocation   SOUNDNESS OF BUSINESS & WORKFORCE

The book of Eggleston (2015) states that the risks are allocated to the best parties to manage them, but this should be revised. The NEC3 just lists the client's risk and all other risks are allocated to the contractor resulting in a wide range of risks allocated to the contractor. It could be possible that this involves risks that he cannot manage. Despite this ambiguous situation, the most important risks are included in NEC3 and these are allocated to the party best able to control them. Unknown risks neither party can control (unavoidable loss or damage, war, non-insurable events) are allocated to the client, together with risks that the client influences (for example design faults of the client). The unknown risks (extreme weather conditions & 'force majeure' events) are formulated too broadly as well, what means that the

contractor has the ability to claim an extension of time for many events and recover additional costs in his advantage. When a client deletes this clause, the contractor is not protected against these 'force majeure' events under the common law of England. In the Netherlands this will work in a different way because there is always a form of reasonableness and fairness in the Dutch law which will free the contractor of these high risks.

The contractor is liable for the risks that the contractor influences such as damage to the works & equipment. The risk allocation becomes more complex because it is not clear how the risks clauses in the contract interact with the Compensation Events clauses. CE clauses state that the contractor is entitled to compensation, but in some cases the contractor has to compensate the client for contractor's risks (risks clauses that state that some CE are actually contractor's risks).

Verification ICC

What is unclear for many Dutch construction experts is that NEC3 avoids the usual practice of detailing the contractor's risk and stating the client's risks as exceptions. It details the client's risks and places all other risks on the contractor. There is a contradiction in the listed compensation events and the risks clauses because some compensation events are listed in the risks clause as contractor's risks. In other words, risks clauses state that the contractor has to compensate the client for contractor's risk while the clause of compensation events suggests an entitlement of compensation for the contractor. However, there will always be risks that no one has thought of because of the uniqueness of every project (de Kleijnen on behalf of tender participant TBI, personal communication, November 3, 2015). All risks that are not named under compensation events, are automatically at the expense of the contractor.

7) Continues improvement	QUALITY PERFORMANCE

The performance of the contractor could be monitored and measured against Key Performance Indicators when secondary option clause X20 is applied. Especially when option C target contract is chosen, multiple incentives for the contractor are introduced by means of payments.

The goal of this section was to create a clear vision of the NEC3 contract in practice in terms of the trust between the involved stakeholders before making a start with the SEM analysis.

The mean score of the NEC3 contract in general is 2.87 and the score of the NEC3 contract applied to the ICC project 3.3. This difference lies in the transparent communication system (SharePoint) that was used during the project, the trust that was gained during the procurement and the clear risk allocation during the whole project.

The criteria named in the case study (Meng et al. 2011) relate to the factors that rose up during the course of the review namely Trust, Soundness of Business & Quality performance as parts of SM and Planning & Control as a part of RM. Criteria 1 Trust during procurement and criteria 4 Communication relate to the Trust factor, criteria 3 Collaboration during project and criteria 6 Risk allocation relate to the Soundness of Business and Workforce, criteria 2 Objectives & 7 Continues improvement relate to the Quality of Performance and criteria 5 Problem solving relates to the Planning & Control. These four factors are included in the first column of tables 4.2 and 4.4.

The project of ICC is assessed according to the seven criteria, to set up a worthy questionnaire.

All these factors are perceived to have an influence on the success of a temporary project. In the literature review the conclusion was drawn that researchers are not consistent in stating the perceived project success factors, i.e. on the one hand 'time' is seen as an important aspect and on the other hand the process and quality is perceived much more important. The next section 'Structural Equation Modelling' will confirm of reject these assumptions.

Structural Equation Modelling

4.3.4 Framework for SEM

All the steps that have been taken in previous paragraphs had the same goal: to get a clear understanding of the positive and negative influences of the NEC3 contract on construction projects. At first the important clauses of the NEC3 contract were elaborated where certain RM tools of the contract emerged, such as the early warnings, sanction for failing to give early warnings, risk reduction meetings. Also SM tools such as communication clauses, transparent open book system, trust clause and pain/gain mechanism were discussed in detail. Providing for a chapter on the conventional RM tools and SM tools was a way to see the contract in perspective. Introducing the maturity model in the review seemed as a deviant step (by adding even more assessment tools), but it helped to assess the contract in practice in a verified way.

Now that the gathered information on NEC3 is examined in the literature review and the case study, the items that represent the latent factors in the NEC3 contract are explored in the next section. To be able to answer the sub questions of this research (What are the success factors of NEC3 in the Netherlands given the success factors in the UK & What are the perceived advantages of NEC3 in the interrelationship between RM and SM components) a national survey within the Dutch construction industry will be conducted to construct a plausible SEM model. The final structural model will highlight the relational links between the factors associated with the performance and the success of a NEC3 project with help of confirmatory factor analysis. The goal is to analyze the standardized coefficients among the factors to understand the effects of the clauses in the contract. The relevance of the SEM model is to prioritize the factors and attributes in terms of the perceived importance/criticality. When using SEM, the sample size, construct validity assessment are pitfalls for many researchers. Problems in model development are linked to untidiness over some critical issues in the research design stage. Implications of the observed literature are the search for a proper Latent/Observed variables and sample size.

Hypothesized model

This research tries to get a better understanding of the effects of the criteria in the NEC3 contract selection when starting a complex construction projects in both project development and delivery contexts. Doloi et al. (2011) conclude that an outcome of a SEM is important for all involved stakeholders to prioritize underlying items and factors in terms of their criticality for developing sound contractual arrangements (p. 688). The relational links between the factors associated with the NEC3 contract criteria and the overall projects success will be highlighted by SEM. To start analyzing the involved factors, a hypothesized model should be structured with the help of the case study and the literature review.

Looking back at the flow diagram presented in the research criteria of the literature review, the end goal of this research is to come to the project success of NEC3. The last step of the diagram (where all parts convert into the success of a NEC3 project) represents the SEM model, shown in figure 4.2.
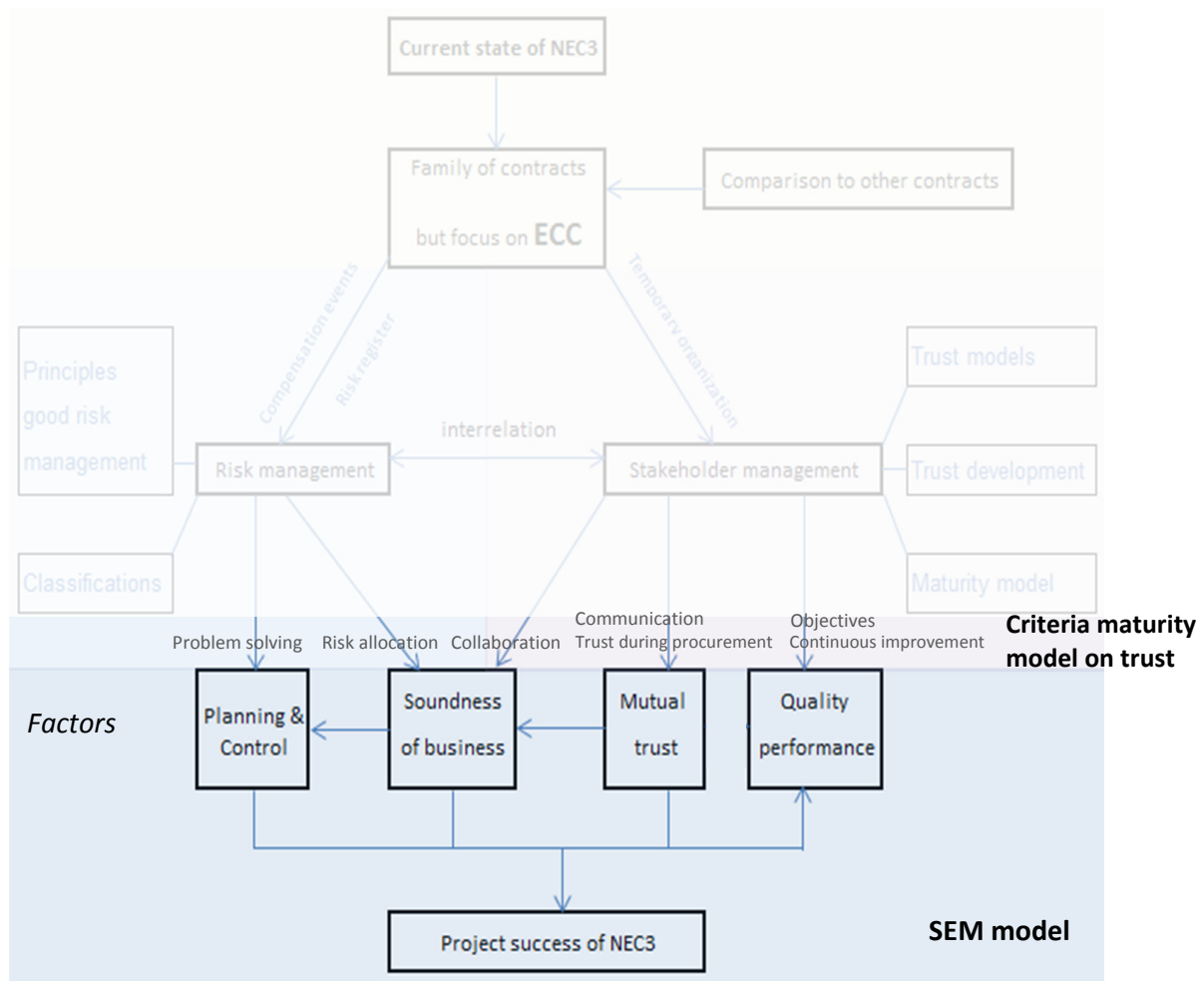
Figure 4.2 Hypothetical model of the relationship between NEC3 performance and overall success of project

All the important items/attributes that underlie the four factors presented in the diagram above, are discussed in the review and in the case study as parts of RM and SM. The (dependent) fifth factor 'Project success of NEC3' is hypothesized to be influenced by the other factors. Not all the attributes that rose up during the process of this research could be modelled in SEM because the model will then be too complex and unclear.

The choice was made to further develop the model by attributes that best present certain clauses in NEC3 and criteria named in the self-structured trust maturity model (problem solving, risk allocation, collaboration, communication, trust during procurement, joint objectives and continuous improvement.

This section summarizes the review and the case study on NEC3 with regard to the factors involved in a complex TMO, when choosing for a NEC3 contract. It is assumed that Trust (T) is an important factor for establishing a successful project. Next to Trust (T), Soundness of Business & Workforce (SBW), Planning & Control (PC), Quality Performance (QP) together determine the success of a NEC3 project adapted from Davis (2014), Doloi et al. (2011) & Wong et al. (2005). These latent variables are supported by items of measurement revealed in the review and case study. Some items play an important role in this research, such as the clearness of the contract document as part of System-Based Trust within Trust (T), a clear risk allocation policy and liabilities as attributes of Soundness of Business & Workforce (SBW), an

early warning system as an attribute of Planning & Control (PC) and common interests (joint goals) as attribute of Quality performance. These are a few examples of attributes that came to the surface in the review. The following attributes/items of measurement have been abstracted from the observed literature:

Trust is an essential part of the NEC3 contract and is seen as an important factor in the literature review because it is perceived to be influenced by three other latent factors according to Cheung et al. (2011) shown in table 3.7. These factors are System-based Trust (ST), Cognition-based Trust (CT) & Affect-based Trust (AT). Together they are defined by nine key attributes namely clearness defined job tasks (ST1), clearness defined contract documents to bring confidence and comforts to all parties (ST2), the contractor's qualification level (ST3), attending work-related interaction (CT1), available information of parties to judge competences (CT2), good interaction to obtain information from other party (CT3), Personal relationship improving working relationship (AT1), taking each party's needs into account in decision-making process encourages satisfactory outcome (AT2) and feeling that the contractor will not damage the interests of other parties (AT3).

Clause 10.1 of the NEC3 contract states that the contracting parties should act in a spirit of cooperation and mutual trust. The existence of an instrument to evaluate trust does not exist, but the mutual trust could be realized by project management tools such as the early warning system, compensations events and risk reduction meetings which are incorporated into the contract. This ensures the involved stakeholders to get confident in the system and that problems would be jointly dealt with.

Technical expertise of the organization (SBW1), Attitude towards defects liability (SBW2), Close collaboration (SBW3) and Clearness of risk allocation policy (SBW4) are items involved in the factor Soundness of Business & Workforce (SBW) (Doloi et al., 2011; Eggleston, 2015; Evans, 2013) discussed in chapter 3.6. The last attribute 'Clear risk allocation policy' is a result of the ambiguous risk distribution for the Dutch construction industry, verified by (de Kleijnen, 2015) naming all Client's risk in clause §80.1 instead of the contractor's risks.

Planning & Control (PC) is an essential driver in managing projects successfully (Watermeyer, 2009). Planning & Control and Soundness of Business & Workforce are perceived as mutually inclusive in the context of the success of a NEC3 project, because the planning of a project will become better when the soundness of the TMO is high. The associated attributes of Planning & Control are the early warning system (PC1), a very detailed work specification with all necessary information included in the contract (PC2) and flexibility in the critical path (PC3). It is assumed that the planning and control will affect the quality performance of a project. This latent factor is measured by the tender quality involved in the contract (QP1), the detailing of the safety records (QP2), the quality of the control of the risk programs (QP3) and the joint goal settings (objectives) (QP4).

The four factors mentioned above are perceived to have an influence on the overall success of a project. As stated in the literature review, the meaning of success on a project is very different (Koppenjan et al., 2011; Koops, Coman, Bosch-Rekveldt, & Hertogh, 2015; Turner & Zolin, 2012). In this research the assumption is made that the most notable success measures lies in four key attributes. These are controllability up to project delivery (OSN1), cost savings (OSN2), on time delivery (OSN3) and good added value (quality) (OSN4).

Using the dimensions of the factors involved in a NEC3 collaboration, a hypothetical diagram for making the structural model is presented in figure 4.3, with the latent and observed variables obtained from table 4.5 presented on the next page.
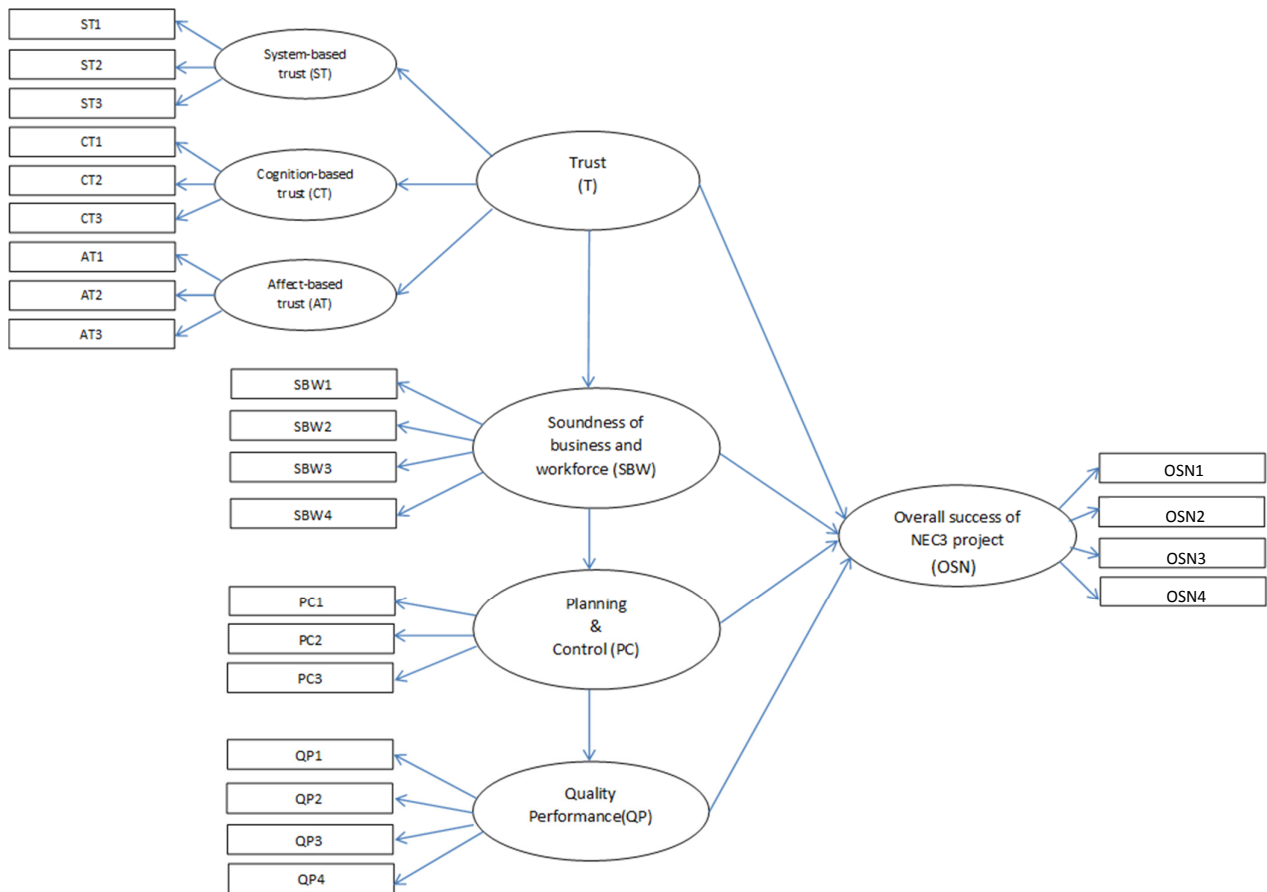
Figure 4.3 Hypothetical model of the relationship between NEC3 performance and overall success of project
Note: Adapted from 'Structural equation model for assessing impacts of contractor's performance on project success' by Doloi et al., 2011, *International journal of project management,* p. 690.

Table 4.5

Latent factors and measured (observed) variables

Factors & initial measurements			
Factors		Attributes/items of measurement	Source
Trust	System-based trust	Clearness defined job tasks	Cheung et al. (2011)
		Clearness defined contract documents	
		The contractor's qualification level	
	Cognition-based trust	Attending work-related interaction	
		Available information of parties to judge competences	
		Good interaction to obtain information from other party	
	Affect-based trust	Personal relationship improving working relationship	
		Taking each party's needs into account in decision-making process encourages satisfactory outcome	
		Feeling that the contractor will not damage the interests of other parties	
Soundness of business & workforce		Technical expertise	Doloi et al. (2011) Eggleston (2015) Evans (2013)
		Attitude defects liability (defects date)	
		Close collaboration	
		Clearness of risk allocation policy	
Planning & control		Early warning system	Broome (2015); Gould, 2007); Watermeyer (2009)
		A very detailed work specification with all necessary information included in the contract	
		Flexibility in the critical path of the planning	
Quality performance		Tender quality (sufficient time to profile each tenderer)	Hatush & Skitmore (1997)
		Detailing of the safety record	
		Quality of the control of risk programs	
		Joint goal setting (objectives)	
Success of NEC3 projects		Controllability up to project delivery	Own expectations regarding literature on NEC3
		Cost savings	
		On time delivery	
		Good added value (quality)	

Table 4.5 shows the unobserved factors with their perceived attributes. As could be noted, the criteria of the maturity model are (completely or abbreviated) integrated as attributes of the five factors that are extracted from the literature review: criteria 1 Trust during procurement is part of System-Based Trust, criteria 2 Objectives is part of Quality Performance, criteria 3 Collaboration is part of Soundness of Business, criteria 4 Communication is part of System-Based Trust, criteria 5 problem solving is part of Planning & Control (early warning) and criteria 6 Risk allocation is a part of the factor Soundness of Business.

Revised hypothesized model based on review and assumptions

The appropriateness of employing factor analysis within SEM should be assessed in this study. Two aspects should be taken into account. Firstly, the article of Chan et al. (2012) showed that there is a specific ratio for the number of variables in relation to the necessary sample size to proceed with factor analysis (p. 15), namely 1:5. At this point there are 24 attributes what means that a sample size of 120 respondents is required. Also when looking at the hypothesized model, the trust part is a structural model in its own and makes the overall model very complex. For this reason, the trust part is being reconsidered.

Secondly, the three trust types of Cheung et al. (2011) are mutually dependent and a system is only as good as its weakest point. The model presented in the previous section was very complicated because of the Trust part; three latent factors defined by nine items. These three factors are assumed to have a higher order common factor Trust (T). Summarizing, there is a second-order model within the whole structural model. The three latent factors should be made measurable to be able to continue with this hypothesized model. This is a long and complicated process, so the choice is made to revise the Trust part.

The choice is made to capture the trust in the measurement model as system-based trust, because this trust type is the most measurable component of the three types. Were the project manager must set up a plausible system, NEC3 focuses mainly on system-based trust were formalized and procedural arrangements can build trust and strengthen communication channels between contracting parties because the system provides for certainties. Wong & Cheung (2005) & Cheung et al. (2011) concluded in their articles that when there is no trust in the system and among business partners, this has strong negative consequences for the project and argue that the existence of System-Based trust in fundamental if the contracting parties have no previously working relationship. The contract of NEC3 and the project management system form the platform where understanding is further developed.

The initial model is shown in figure 4.4. As explained in above section the SEM model of trust is a second order model that should be revised due to complexity of the model. The nine attributes that are assumed to be responsible for System-Based Trust, Cognition-based Trust & Affect-based should be validated in an own SEM model. Refinements of the model, i.e. with the help of Goodness-of-fit measures should validate or reject the simplified revised model. In the revised model six attributes are eliminated with the notion that they individually have a lower correlation with the attributes of the other latent factors, followed by adding 'Transparent communication system (SharePoint)' as a comprehensive fourth attribute that sums up all six attributes of Cognition-based trust (CT) and Affect-based Trust (AT) together and represents the fourth attribute of System-Based Trust (ST4). This attribute is a congregation of actually every other attribute that is left out the revised model. Figure 4.5 shows the significant change of revising the second order model into a first order model.
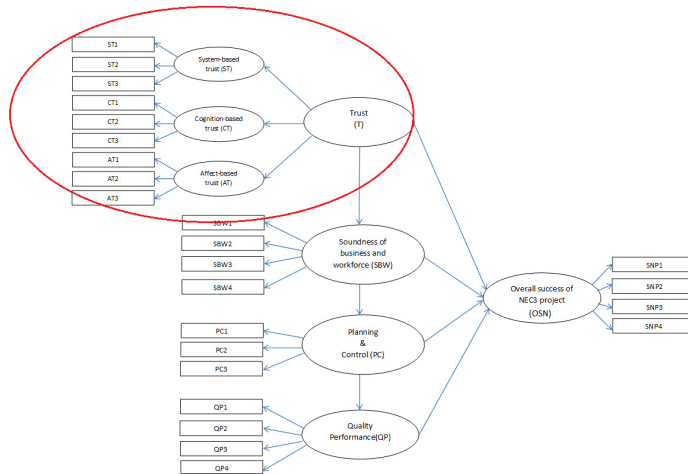
Figure 4.4 Complex hypothesized model revising Trust part
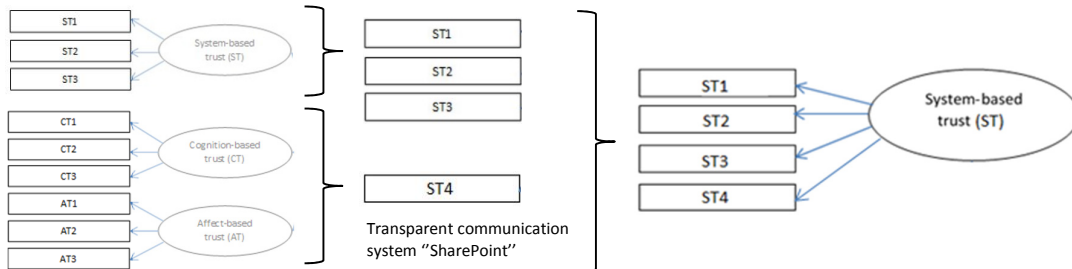
Figure 4.5 The separate second order SEM model on Trust transformed into System-based trust with addition ST4

The assumption is made that work-related and personal interaction between the stakeholders in the form of a transparent communication system ''SharePoint'' (a comprehensive attribute that covers the Cognition-based Trust (CT) and Affect-based Trust (AT)) can enhance the communication system of a TMO. A communication system can be seen as an important added value for System-based trust (ST) (S. O. Cheung et al., 2011).

Because it is important for this research and the NEC3 contract that the final SEM model is comprehensive, this attribute should be included in the revised hypothesized model. This attribute is packed as '**transparent communication system, SharePoint' (ST4)**.

For the questionnaire the first hypothesized model is used to formulate the questions, to validate the assumptions made in this section.

The complete revised model is presented on the next page, together with the associated factors and items of measurement table. Trust is now called System-Based Trust, but with this factor the overall mutual trust is meant in a NEC3 collaboration: 'The trust in the NEC3 system'.

To be able to start with SEM hypotheses should be drafted regarding certain relations in the hypothetical model. The direction of the arrows in the model represents the influence.
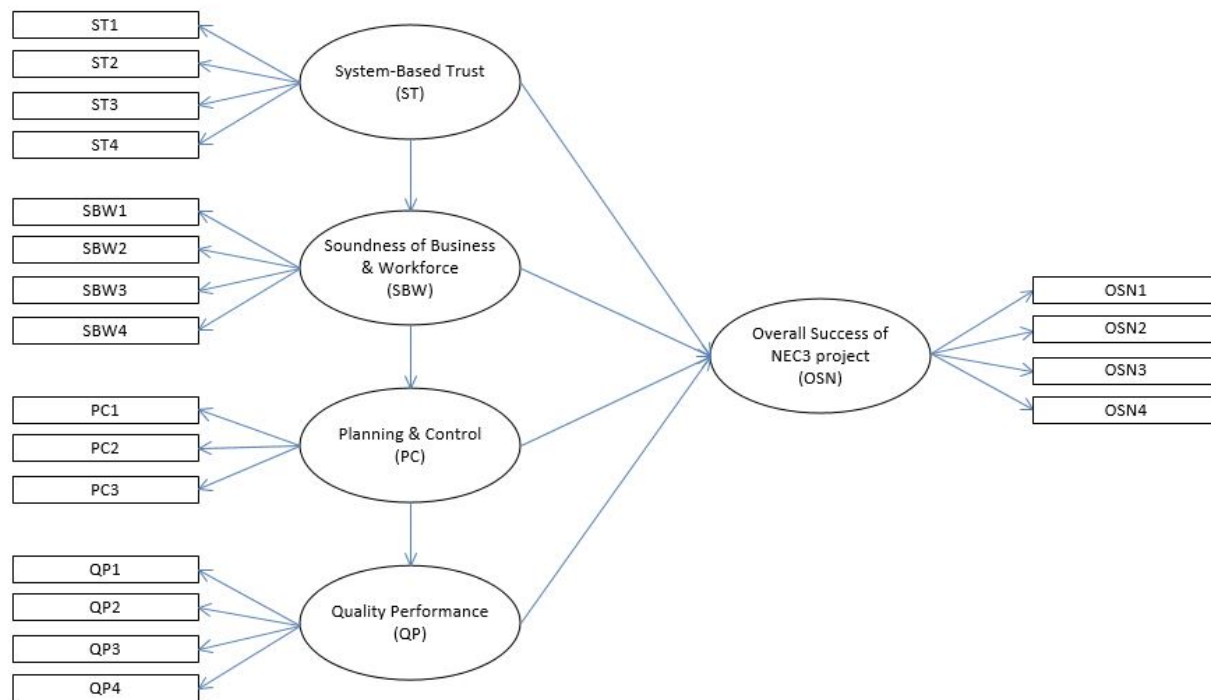
Figure 4.6 Hypothetical model of the relationship between NEC3 performance and overall success of project

Table 4.6
Underlying latent factors and measured (observed) variables

Factors & initial measurements		
Factors	Attributes/items of measurement	Source
System-based trust	Clearness defined job tasks	Cheung et al. (2011)
	Clearness defined contract documents	
	The contractor's qualification level	
	Implementing a transparent communication system for work-related and personal interaction to obtain information from other parties and to understand each other better to avoid ambiguous situations	
Soundness of business & workforce	Technical expertise	Doloi et al. (2011) Eggleston (2015) Evans (2013)
	Attitude defects liability (defects date)	
	Close collaboration	
	Clearness of risk allocation policy	
Planning & control	Early warning system	Broome (2015); Gould, 2007); Watermeyer (2009)
	A very detailed work specification with all necessary information included in the contract	
	Flexibility in the critical path of the planning	
Quality performance	Tender quality (sufficient time to profile each tenderer)	Hatush & Skitmore (1997)
	Detailing in the safety record	
	Quality of the control of risk programs	
	Joint goal setting (objectives)	
Success of NEC3 projects	Controllability up to project delivery	Own expectations regarding literature on NEC3
	Cost savings	
	On time delivery	
	Good added value (quality)	

The goal of figure 4.6 and its corresponding table 4.6 is to figure out which attributes are valued the most important according to experts in the Dutch construction industry to be able to answer research question 5: What are the success factors of NEC3 in the Netherlands given the success factors in the UK?

Because this research makes use of confirmatory factor analysis, prior hypothesis should be formulated. Based on these hypotheses, a questionnaire will be structured in a way that the respondents must value all the attributes on a scale without mentioning the underlying five unobserved factors. The goal is to see if SPSS AMOS (program to model SEM) is able to extract indeed five factors by detecting a certain pattern in the valued attributes by means of structural equations. In other words, AMOS should be able to detect certain clusters of attributes that all represent for example the same underlying factor Planning & Control. This is only possible when a respondent values all attributes of Planning & Control significantly different than another attribute. Another respondent could value the attributes of Planning & Control significantly lower than the attributes of another, but the program will still be able to detect a certain pattern in this way.

Now that the hypothesized model is complete with 19 attributes, there are other variables that could influence the way the respondents answer the questions. The questionnaire should therefore include questions concerning personal information of the respondents. For example experience in the construction industry, knowledge of the contract of the expert could affect the final model. These 'moderators' could be used as two additional hypothesis.

Hypothesis 1)
The success of a NEC3 project improves, when the System-based trust (ST), the Soundness of Business and Workforce (SBW), Planning & Control (PC) & the Quality Performance (QP) are becoming at a higher level.

Hypothesis 2)
The Soundness of Business and Workforce (SBW) improves when the System-Based Trust (ST) due to the contract is improved.

Hypothesis 3)
The Planning & Control becomes (PC) of a NEC3 project improves when the Soundness of Business and Workforce (SBW) is improved.

Hypothesis 4)
The Quality of the project performance (QP) of a temporary project improves when the planning and control (PC) of a NEC3 project is improved.

Hypothesis 5)
Experience in the construction industry moderates positive effect of Planning & Control (PC) on the Overall success of a NEC3 project (OSN).

Hypothesis 6)
Knowledge of the Contract moderates positive effect of Planning & Control on the Quality of the Performance (QP) and on the Overall project success of a NEC3 project (OSN).

As can be seen in the hypothesized model, it is hypothesized that the four underlying factors System-Based Trust, Soundness of Business, Planning & Control and Quality Performance all have a relation with the overall success of a NEC3 project. The hypothesis states that the fifth latent factor (dependent) 'Overall success of a NEC3 project' will be influenced by the four latent factors (shown in figure 4.6) what means that this fifth latent factor will be placed on the right side of the other factors in the final structural model. However, the assumptions is made that the four other factors also relate to each other, what makes them dependent variables. The analysis should reveal this dependency.

The hypothesized model illustrates the relationship between the five factors and is a check for the final structural model to see if the assumptions in the hypothesized model were correct. The measurement model (figure 4.9) in the further factors analysis serves to explore if relationships between the latent variables and their attributes/items are satisfactory and to illustrate the co variances between the five latent factors.

In other words, the underlying factor 'Overall success of a NEC3 project' will be assessed the same as the other four factors and is equivalent in the questionnaire and the factor analysis. The used program for this research, SPSS AMOS, is able to transform a measurement model in a structural model.

Questionnaire

The research method was adopted to test the hypotheses proposed in the previous section. The setup of the questionnaire is a little more different than the setup of the bundled questions in Appendix B. While the bundled questions were structured as an alternative form of a semi-structured interview (open, allowing new ideas to be brought up during the interview as a result of what the interviewee says), the questionnaire is structured as an online tool and is only meant for Dutch experts. The online tool that was used for this research is Thesistools. People were contacted by email (shown in appendix C). This email is in Dutch, but in the email an explanation is included why the questionnaire is in English (for all participants). Most respondents are employees of HEVO. Other respondents were collected through the PPS Network where the supervisor of this research is part of and through two subsidiaries of TBI were HEVO is also part of (TBI is shareholder of many companies in sectors Engineering, Construction and Infrastructure). The companies of ERA Contour and Synchroon show the most resemblance with HEVO.

Another difference is that the questionnaire was drafted for actors with or without knowledge of the NEC3 contract to assess the performance of NEC3 projects. The questionnaire is designed to evaluate the hypothesized model. The Trust, Soundness of Business & Workforce, Planning & Control and Quality Performance are evaluated as factors influencing the success of a NEC3 project. The respondents do not need specific knowledge of the NEC3 contract but need to have experience in the Dutch construction industry. The questions were phrased to get an affirmative response of the actors on relevant items impacting the success or failure of a NEC3 project. Some participants with no knowledge of the contract will answer the questions, not knowing that these indicators are clauses in the contract. Everybody will assess the questions with their general knowledge of the building industry, some of them will have experience with the British contract. The objective of this difference is to discover if these experts answer the questions differently.

Before sending the questionnaire to all respondents, a pilot study was conducted among a colleague of HEVO explaining the content and the purpose of the research to validate the content for accurate translation: some questions were difficult to understand because it is in English.

Structure

As can be seen in Appendix D, the first 6 question relate to the personal information of the respondents (experience, knowledge etc.). These questions can serve as moderators or controllers for the structural model. Moderators are third variables which could influence the relationship between two other variables. For example, the experience of the expert can influence the way he responded to certain questions. Controllers (control variables) are variables in the analysis which are constant and unchanged throughout the analysis. The controllers influence the results but are constant during the analysis in order to test the relationship between the dependent factors. For example, the work field of the expert is a constant variable that could influence the way of thinking of the expert. Appendix D shows also that the questions 7d-i concerning cognition-based trust (CT) and affect-based trust (AT) are still present. These are omitted in the further analysis. These questions were still part of the questionnaire because the initial plan was to validate the revised hypothesized model with an individual structural model on the Trust part including the three sub part of ST, CT & AT.

However, due to later conversations with experts this was not performed. Question 12 is an additional question that tends to get a better understanding of the four factors process, cost, time and quality but is not a part of the structural model.

ThesisTools provides for a excel document with all the responses. These responses will be analyzed in the following paragraphs by using excel itself, IBM SPSS Statistics 22 which will be input for IBM SPSS AMOS. AMOS is a statistical tool that provides structural models and calculates the loadings of each items on the factor and the interrelation of the factors based on a specific dataset.

The questionnaire was developed in a way that AMOS should be able to extract the five latent (unobserved) factors by itself based on the item scores. In other words, the questionnaire never mentions the five unobserved factors System-Based Trust, Soundness of Business, Planning & Control, Quality Performance and Overall Success of a NEC3 Project, it only asks to assess the (observed) items on a scale of one to five. Amos must detect a pattern in the answers (i.e. all items of the questions related to Planning & Control are assessed lower than the items of Soundness of Business in one response and in another response the items of Planning & Control are assessed a little higher than the items of Quality Performance. In this way a factor analysis could detect that certain items belong to an underlying factor and calculates the contribution of each items to the underlying factor. For example, the perceived contribution of the early warning system on the Planning and control of a NEC3 project.

In the next paragraph the dataset obtained by SPSS will be analyzed to see if the data is suitable for the SEM analysis.

4.3.5 Data screening

<u>Case screening</u>

Circa 130 mails were send to personal mail addresses (HEVO, Synchroon and ERA Contour). The PPS Network of the Netherlands distributed the questionnaire also by mail and included the link to the questionnaire in the newsletter. The PPS network has a range of thirty connected participants and 18000 newsletter readers. An important aspect is that only Dutch experts were approached to participate. In total this is a wide range of respondents, however there was personal interaction with only 130 of them in confirming willingness and participation.

<u>Missing data</u>

In total 135 experts in the Dutch building industry filled in the questionnaire as shown in Appendix table 1. These 135 questionnaires include also blank questionnaires (for example when the 'submit' button is not used because someone

Figure 4.7 ThesisTools questionnaire – 135 respondents

closes the site midway through the questionnaire, or when the questions were not what they expected or the questions were too difficult etc.). These blank questionnaires were filtered out of the excel output of the ThesisTools website by using the function =countblank(E1:AO1). The data was sort by the blank questionnaires. As can be seen in Appendix E Data screening table 1, there were 34 blank digital questionnaires (all missing 19 values). These were deleted from the data file. Next to the blank questionnaires, some respondents did use the submit button but did not fill in the questionnaire. This resulted in 7 invalid questionnaires (all questions from question seven had the value of zero or had more than 8 missing values).

<u>Unengaged responses</u>

Questionnaires that were answered unengaged means that respondents answers every question with the same value. Variances in the responses is very important for SEM. For example, an increase in the quality of the performance will not make any difference when looking at the increase of success of the NEC3 project because there is no increase (they stay the same) (Gaskin, 2013). Therefore, unengaged responses should be deleted. This could be detected by measuring the standard deviation of the latent variables in the excel output of the questionnaire (=stdev.p(J2:AO2). Gaskin (2013) argues that any standard deviation value under 0,5 is useless. However, we want to delete as little data as possible, so every value under 0,3 is deleted. Table 2 in Appendix E shows that there were no unengaged respondents in this questionnaire.

<u>Outliers</u>

The missing data and the unengaged responses are deleted from the data. As mentioned before, six additional questions were asked concerning the experts' work field, experience etc. These moderators will be used in the structural model to see if for example the experience of

the respondents has an influence on the outcome of the analysis. To get a good overview of these six questions, the excel file of the responses is copied to SPSS. SPSS is able to map these questions in a simple graph that shows the 'outliers' of the experts' answers. These outliers present observations points which differ from other observations. The boxplot is shown in figure 4.8.
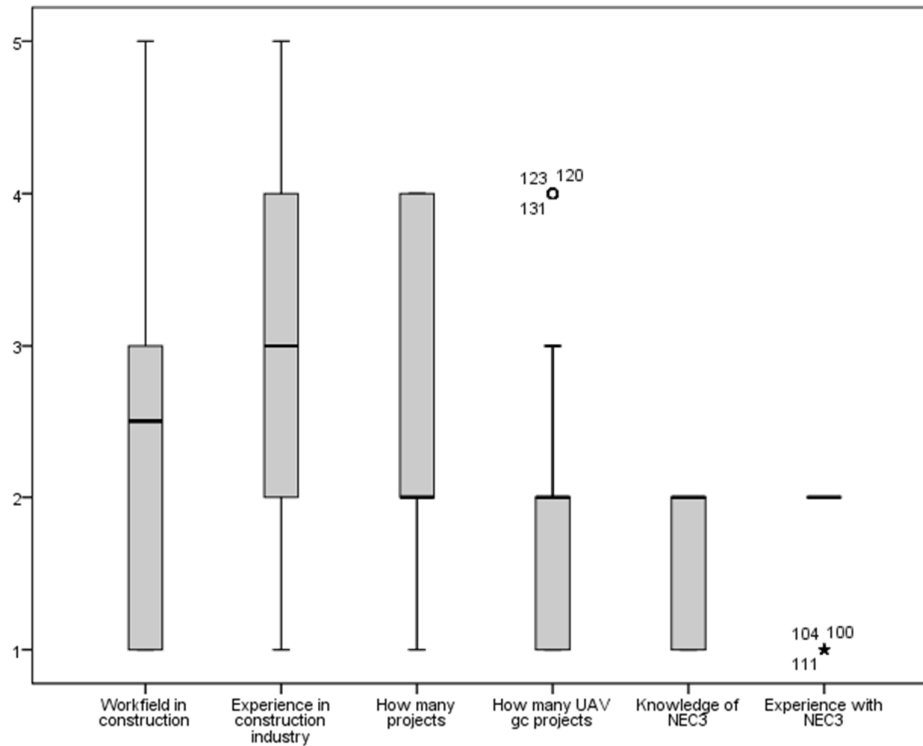
Figure 4.8 Boxplot presenting outliers

This boxplot shows us that there only a few respondents with NEC3 experience, but that the knowledge (or no knowledge) of the contract is equally distributed. This plot also shows that most of the respondents have not that much experience with UAV-GC projects than expected. Table 4.7 presents these findings in percentages.

Table 4.7
Profile of the respondents

Workfield		Experience		Completed UAV-GC projects		Knowledge of NEC3		Experience with NEC3	
Project Manager	40,4 %	<5	13,8 %	<2	47,9 %	YES	48,9 %	YES	13,8 %
								NO	86,2 %
Contractor	9,6 %	5-10	21,3 %	2-5	31,9 %	NO	51,1 %		
Consultant	35,1 %	11-15	22,4 %	6-10	6,4 %				
Architect	3,2 %	16-20	19,1 %	>10	13,8 %				
Other	11,7 %	>20	23,4 %						

Variable screening

Missing data

Next to the missing data on case level, there is also missing data on variable level. When respondents overlooked some questions mid through the questionnaire this will result in an invalid value of zero. When the excel file is copied to IBM SPSS, the function Analyze->Descriptive statistics->frequencies could be used to see if there is any missing data. Table 3 in Appendix E shows the missing variables table (only the missing data is presented instead of the whole frequencies table. As can be seen in this table, there are 7 missing values. These are replaced by the median of nearby point in order to lose as little as possible data:
Transform->replace missing values->select the seven items that are missing values-> select median of nearby points (see table 4 in Appendix E). By changing these missing values by the median of all nearby points, this leads to **94 valid questionnaires**.

Kurtosis

In probability theory and statistics, kurtosis is a measure of the tailedness (marginal distribution) of the probability distribution of a real-valued random variable. Kurtosis is a descriptor of the shape of a probability distribution and there are different ways of quantifying it for a theoretical distribution and corresponding ways of estimating it from a sample from a population. When there is a high positive kurtosis value, the respondents answered the questions very similarly (the distribution is very small). When there is a high negatively kurtosis value, the respondents answered very differently and there was no central tendency towards the median (Gaskin, 2013).
In SPSS the kurtosis is measures by: Analyze->descriptive statistics->frequencies->statistics->select kurtosis. The corresponding table is presented in Appendix E table 5. This table shows SBW1 (Technical expertise) and NEC3experience (people who answered the question 'Do you have knowledge of the NEC3 contract' with yes, received a supplementary question 'Do you have experience with the NEC3 contract') were answered very similarly and that the question 'Do you have knowledge of the NEC3 contract' was answered very differently. The last two are easy to declare. The question 'Do you have knowledge of NEC3' has only two options namely 1 for YES and 2 for NO. The distribution of this question is high (a high negative kurtosis) because exactly half of the respondents answered 1 and the other half 2, so this question is not answered similarly. The question 'Do you have experience with NEC3' is asked to the respondents that answered the previous question with yes. This attribute NEC3experience has a high positive kurtosis, because most of the people with knowledge of the contract had also experience with the contract (even if it is experience with a tender, a project etc.). The other one is more difficult to explain. This attribute should be monitored closely.

4.3.6 Exploratory factor analysis

Paragraph 4.3.1 stated that only confirmatory factor analysis would be used for this research as a first step to assess the proposed measurement model in a structural model. But before starting the confirmatory analysis, a few exploratory measurements have to take place to test if the results are operable for confirmatory factor analysis.

Simply using CFA in an exploratory fashion can be restrictive. The idea that CFA is a solely confirmatory analysis is misleading because modification indices used in CFA are also exploratory (these indices show the improvement in the model fit if a coefficient becomes unconstrained.

The two concepts of exploratory and confirmatory do not have to be exclusive analyses.

The goal of the exploratory factor analysis is to find out if there are indeed five latent (unobserved) underlying factors that represent the 19 variables which are part of the NEC3 contract.

To start with the exploratory factor analysis, the first test is to see if the data is suitable for SEM. The sample size is of high importance. Chan et al (2012) argues that employing factor analysis is appropriate when the sample size is considered sufficient as it complies with the ratio 1:5. (p. 15). Looking at the hypothesized measurement model, there are 19 variables/attributes present. This means that the sample size must be 95 or higher. 135 experts participated in the questionnaire but only 94 of them were suitable for the analysis. The function of Kaiser-Meyer-Olkin (KMO) in SPSS can be used to see if the sample size is suitable for performing confirmatory factor analysis. Chan et al (2012) states that the value of KMO ranges from 0 to 1 and that the KMO value should be greater that the acceptable threshold of 0,5 for a satisfactory outcome. A KMO of 0 means that the sum of partial correlations is large relative to the total sum of correlation which would not be appropriate for further analysis.

Analyze->Dimension reduction-> Factor analysis->Descriptives->KMO. The KMO of the response of this research is 0,612. This means that the results are for further factor analysis.

Table 4.8 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,612
Bartlett's Test of Sphericity	Approx. Chi-Square	558,161
	df	171
	Sig.	,000

Now that the KMO is sufficient, the EFA will proceed by executing the Maximum Likelihood analysis (ML) with Promax rotation. The maximum likelihood analysis within the factor analysis allows to test the significance of the factor loadings and to calculate the correlations among the factors and rotation means that the factors are rotated in an attempt to achieve a simple structure when performing an analysis (''rotation of the factor dimensions to obtain simple and interpretable factors'' (Yaremko, Harari, Harrison, & Lynn, 1986)). These two procedures are executed for factor analysis to find out if there are indeed 5 underlying 'latent factors', presented by the 19 items.

When performing the factor analysis, SPSS presents a lot of tables including a communalities table and a pattern matrix table. The communalities table presents all the 19 variables and the proportion of each variable's variance that can be explained by the underlying latent factors System-Based Trust, Soundness of Business, Planning & Control, the Quality of the Performance and the Overall Success of a NEC3 project. Variables with a value above 0,5 are well represented in the factor space. Factors below 0,3 should be watched closely. As could be seen in table 4.9 ST4 and SBW3 are not presented well in the factors space of respectively Trust and Soundness of Business.

Table 4.9 Communalities table

	Communalities	
	Initial	Extraction
ST1	,568	,710
ST2	,533	,534
ST3	,497	,325
ST4	,345	,151
SBW1	,434	,758
SBW2	,383	,292
SBW3	,270	,178
SBW4	,452	,317
PC1	,545	,746
PC2	,311	,158
PC3	,549	,746
QP1	,487	,456
QP2	,609	,582
QP3	,573	,700
QP4	,415	,350
OSN1	,501	,367
OSN2	,475	,446
OSN3	,443	,533
OSN4	,455	,250

Extraction: Maximum likelihood

Table 4.10 Pattern matrix

	Factor				
	1*	2	3	4	5
ST1	,792				
ST2	,745				
ST3	,490				
ST4	,313				
PC1		,872			
PC3		,727			
PC2		,393			
QP3			,776		
QP2			,755		
QP1			,601		
QP4			,371		,305
OSN3				,750	
OSN2				,616	
OSN1				,550	
OSN4				,370	
SBW1					,897
SBW2					,410
SWB4					,343
SBW3					,328

Extraction Method: Maximum Likelihood. Rotation Method: Promax with Kaiser Normalization
*The analysis extracted 5 factors, were 1 represents System-Based Trust, 2 Planning & Control, 3 Quality performance, 4 overall project success and 5 Soundness of Business

The pattern matrix within the factor analysis shows the coefficients of all the 19 items which represent the unique contribution to the five latent factors SPSS extracted from the response of the experts. These factors are identical to the hypothesized SEM, only the **sequence** of the factors is different than the hypothesized model because SPSS makes his own sequence based on values and equations. Each row is a regression equation (data with specific coherence) where the variables are expressed as a function of the factors. The more factors SPSS extracted from the response, the lower the coefficients since there are more contributions to the explained variance. 'Variance explained' measures the proportion to which a model accounts for the distribution of a dataset. Factor 1 represents Trust in this case, factor 2 Planning & Control, factor 3 Quality Performance, factor 4 Overall Project Success and factor 5 Soundness of Business.

Iteration to come to a good pattern matrix

As can be seen in table 4.10, QP4 'Joint goal setting (objectives)' loads on two factors (called cross loading). It loads on Soundness of Business and Quality Performance. To be able to continue with confirmatory factor analysis, these cross loadings should be removed. Cross loadings could be removed by looking at the other factors that load onto Soundness of Business. Iteration of the factor analysis is needed to come to a good pattern matrix. These iterations concern meeting the standard indices of a model fit. These iterations could result in the elimination of some of the variables across the five latent factors. Gaskin (2015) argues that there is no right or wrong in this iteration process, as long as you interpret the results in a good way. An acceptable first step is to look at the two factors ST4 and SBW which had low variances. Removing SBW3 in the factor analysis resulted in a lower KMO value and lower coefficient values of ST4 and SBW4 in the pattern matrix, so this is not a good option. Removing ST4 in the factor analysis resulted in a higher KMO of 0,616 and higher coefficients in the pattern matrix of all the other variables. Also cross loadings disappeared by excluding ST4 in the factor analysis. However, ST4 stands for the 'Transparant Communication System (open book)' what is an important part of the NEC3 contract. The goal is to see if this variable has an influence on the Trust level so it remains briefly in the pattern matrix. Another option is to suppress small coefficients of <0,306 so that the cross loading of QP4 on Soundness of Business disappears. Because with cross loadings, AMOS will not run the model.

Table 4.11
Iterated pattern matrix

	Factor				
	1 System-Based Trust	2 Planning & Control	3 Quality Performance	4 Overall Success NEC3	5 Soundness of Business
ST1	,792				
ST2	,745				
ST3	,490				
ST4	,313				
PC1		,872			
PC3		,727			
PC2		,393			
QP3			,776		
QP2			,755		
QP1			,601		
QP4			,371		
OSN3				,750	
OSN2				,616	
OSN1				,550	
OSN4				,370	
SBW1					,897
SBW2					,410
SWB4					,343
SBW3					,328

Extraction Method: Maximum Likelihood. Rotation Method: Promax
with Kaiser Normalization

As can be seen in table 4.11, OSN (Overall project success) is also part of the pattern matrix what means that the respondents extracted indeed five factors from the questionnaire. In this stage of the factor analysis the Overall success of a NEC3 project is treated equally to the other four factors in the factor analysis as explained in paragraph 4.3.4. In a later stage it becomes clear that this fifth factor is perceived to be the outcome of the other factors in the structural model.

Adequacy of the analysis

The adequacy of the analysis have to be checked before moving on to the next step in the factor analysis. The adequacy relates to the KMO and Bartlett's Test, the Communalities and the Total Variance Explained. The KMO (0,612) and the Communalities Table were acceptable for factor analysis, however the cumulative contribution rate of the five factors (the explained variance) is 46 %. Gaskin (2015) argues that the Explained variance should be above 60%.

Convergent validity

The convergent validity concerns the average loading of the items of one factor. Many articles argue that the average factor loading of these items should be higher than 0,7 (0,7*0,7= 0,49, so almost half of the variance of the item is explained by the factor) to confirm that independent variables, the 19 items identified from the literature, are represented by a particular factor. However, for this research 0,7 is a high standard due to the sample size and the obtained data. For this research a lower level of 0,4 is used. Eventually the loadings should be interpreted in the view of the literature. All 19 items are relevant for this research and should be included in further analysis.

Discriminant validity

There are no cross loadings present in the iterated pattern matrix. This means that the discriminant validity is good. Another table represented in the output of SPSS when performing the factor analysis is the factor correlation matrix. This matrix shows the correlations between the latent factors. A correlation between the two latent factors greater than 0,7 indicates a majority of shared variance (0,7 * 0,7 = 0,49) so a correlation should not exceed this value. Table 4.12 shows this factor correlation matrix and as can be seen there is no correlation higher than 0,7.

Table 4.12
Factor correlation matrix

Factor	1	2	3	4	5
1	1,000	0,121	,308	,278	,217
2	,121	1,000	,210	,115	,179
3	,308	,210	1,000	,221	,262
4	,278	,115	,221	1,000	,290
5	,217	,179	,262	,290	1,000

Reliability

Huai et al. (2012) argues that reliability indicates whether the questionnaire can steadily measure the variables. The reliability could be tested by the Cronbach's Alpha: Analyze-> Scale-> Reliability analysis.
A Cronbach's Alpha larger than 0,60 indicates that the survey data is reliable. Table 4.13 shows the Cronbach's Alpha's of the five factors. On average the value is 0,69. As can be seen in the first column, the five factors are numbered according to the numbers extracted from the SPSS analysis. As already explained, this sequence is not equal to the sequence of the hypothesized model.

Table 4.13
Reliability of the data

Factors	Items of measurement	Cronbach's Alpha
1) System-Based Trust	Clearness defined job tasks (ST1)	**0,698**
	Clearness defined contract documents (ST2)	
	The contractor's qualification level (ST3)	
	Implementing a transparent communication system for work-related and personal interaction to obtain information from other parties and to understand each other better to avoid ambiguous situations (ST4)	
5) Soundness of Business	Technical expertise (SBW1)	**0,655**
	Attitude defects liability (defects date) (SBW2)	
	Close collaboration (SBW3)	
	Clearness of risk allocation policy (SBW4)	
2) Planning & Control	Early warning system (PC1)	**0,678**
	A very detailed work specification with all necessary information included in the contract (PC2)	
	Flexibility in the critical path of the planning (PC3)	
3) Quality Performance	Tender quality (sufficient time to profile each tenderer) (QP1)	**0,708**
	Detailing in the safety record (QP2)	
	Quality of the control of risk programs (QP3)	
	Joint goal setting (objectives) (QP4)	
4) Success of NEC3 project	Controllability up to project delivery (OSN1)	**0,700**
	Cost savings (OSN2)	
	On time delivery (OSN3)	
	Good added value (quality) (OSN4)	

4.3.7 Confirmatory factor analysis

The exploratory factor analysis showed that the dataset was (on almost every test) suitable for further analysis. Before starting with confirmatory factor analysis, questions related to the personal information of the respondents should be integrated in the analysis. The questionnaire included the work field, the experience in the construction industry, the amount of performed projects (and the amount of UAV-GC projects), the knowledge of NEC3 and the experience with NEC3 of the respondents. The knowledge and the experience of the experts concerning the contract are relevant 'moderators' that could influence the way they answered the questions. Unfortunately the group with experience of the contract was too small to analyze; only thirteen experts had experience with the contract what leads to unreliable results. Therefore, the further analysis concerning moderators will proceed with the experience of the respondents in the construction industry and the knowledge they have of the contract. One of the hypothesis stated that the experience in the construction industry has an influence in the way experts assess the factors of Planning & Control in relation to the success of a NEC3 project and the other hypothesis stated that the knowledge of the contract influences the way the experts assesses the factors of Trust and Planning & Control in relation to the success.

However, the question concerning the experience had five categories. These categories have to be revised into low and high experience to be able to serve as good moderators in the final model. For this research the assumption is made that people with less than 10 years of experience are categorized as low experience and people with more than 10 years of experience are categorized as high experience in the construction industry. Those people have been through more various forms of collaborations and contracts. The median of experience is 3,00 (proportional to 11-15 years of experience), so everything below the median is interpret as low experience. To transform the five categories in two categories the following steps have to be taken:

Transform->Recode into different variables->Experience-> Rename-> ExpConstruction->Range 1-2 transforms into 1 (low experience) -> Range 3-5 transforms into 2 (high experience). Knowledge of the contract is already in two categories, namely 1 for 'Knowledge of NEC3' and 2 for 'No knowledge of NEC3'.

The paragraph regarding the questionnaire on page 94 mentioned also that the presents of controllers could lead to differences in the results. Unfortunately, the other three questions concerning the personal information that could serve as controllers were asked in the wrong way. For example, the work field is not usable for the AMOS analysis because it has no numeric meaning (an increase in the construct value does not mean an increase in the work field (a score of 1 'project manager' is not less valuable than a score of 3 'Consultant'). The same applies to the amount of projects and UAV-GC projects. Further research could be optimized by including moderators with a numeric meaning

Now that there are two moderators to which the model can be measured, the confirmatory factor analysis can commence in IBM SPSS AMOS graphics version 20.0. To link the dataset of SPSS to AMOS, a plugin was installed for AMOS called the Pattern Matrix Model Builder. This plugin ensures that the pattern matrix of SPSS can be easily copied to AMOS. The pattern matrix contains a lot of information for the final structural model namely the factor loadings of each items and the number of factors abstracted from the questionnaire. The dataset was

copied to AMOS together with the pattern matrix of the factors to create a first-order oblique model and estimated parameters by maximum likelihood. The parameter estimation of the measurement model is shown in figure 4.9. This figure shows the correlation coefficients between the five factors: this figure is **not** equal to the SEM model, as explained in paragraph 4.3.2 'Structure of the research method '.

The left circles are called the measurement **errors** (e1 to e19). These errors are the difference between a measured value of quantity and its true value. For example, ST1 is determined by System-Based Trust ST, but there may be another variable which is not considered in this research. These unobserved variables are called errors.
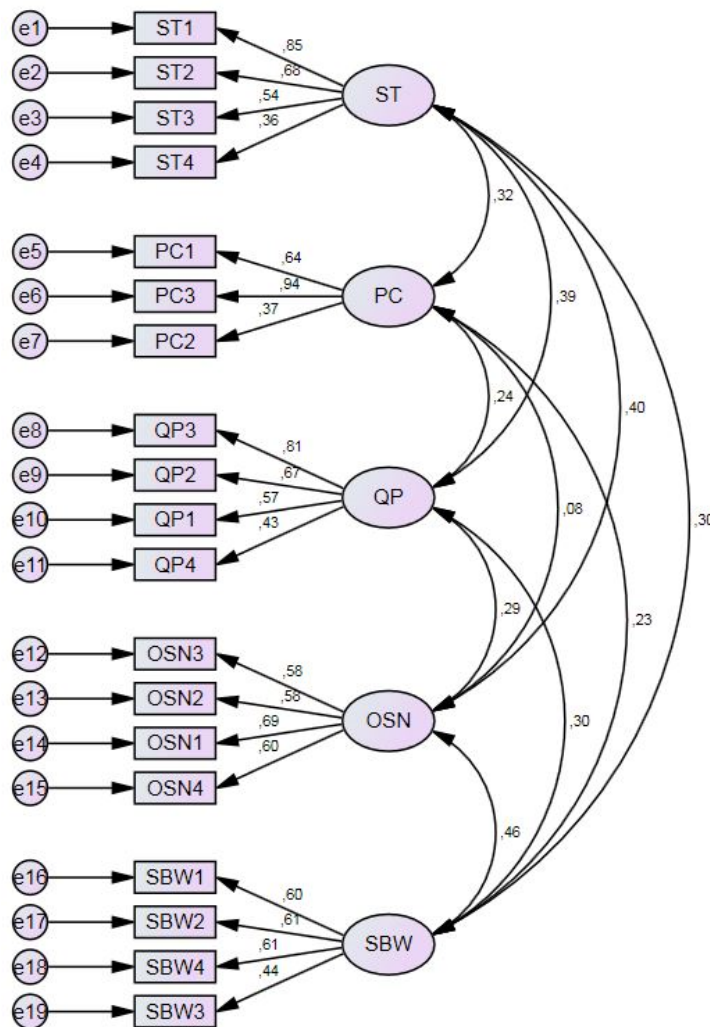
Figure 4.9 Parameter estimation of the measurement model

The initial hypothesized model in figure 4.6 is based on the theoretical background of this study and the clauses of the NEC3 contract. To get a better understanding of how this measurement model relates to the hypothesized model in paragraph 4.3.4, the measurement model presented in figure 4.9 is a predecessor of the final structural model. The factors are presented in the sequence of the SPSS analysis (which is different than the hypothesized

model). The latent factor OSN will be placed to the right sight of the other four factors the co variance arrows will be deleted after the confirmatory factor analysis is completed.

To proceed with CFA, some adjustments have to be made to meet Goodness-Of-Fit (GOF) indices. Figure 4.9 reveals that there are item coefficients lower than 0,5 (what is not favorable when using a small sample size). These are ST4, PC2, QP4, and SBW3. The GOF indices for the initial SEM model can be found in the third column of table 4.14.

Table 4.14
Goodness-Of-Fit measures in AMOS 20.0

GOF measures	Recommended level of GOF	First measurement SEM model	Final SEM model
Degree of freedom	1-2	1,844	1,683
Goodness-Of-Fit index (GFI)	0-1	0,794	0,805
Adjusted Goodness-Of-Fit index (AGFI)	0-1	0,718	0,736
Root mean square error of approx. (RMSEA)	<0,05-0,1(no fit)	0,095	0,086
Comparative Fit Index (CFI)	0-1(good fit)	0,747	0,780
Normal Fit Index (NFI)	0-1 (good fit)	0,596	0,610
Incremental Fit Index (IFI)	0-1 (good fit)	0,763	0,794

The measurement model should be modified in order to improve the fit. Changes in the measurement model are claims that the items are impure indicators of the latent variables specified by the theory presented in the literature. As can be seen in table 4.14, the error of approximation is very high. This means the model does not fit the population data properly. This error also means that the measurement of the data is not precise. This research will not receive a good RMSEA value because the sample size in relation to the amount of items is not ideal. A first step to meet the GOF indices is to look at Modification Indices (MI). These indices could offer remedies for differences between the hypothesized and estimated model. A solution for a better model fit is to co vary the error terms of the items with Modification Indices (only items with the same factor, in this case e2&e3 and e12&e13. Co varying these error terms resulted in higher indices for model fit, shown in the fourth column of table 4.14.

The goal was to alter the measurement model to fit the GOF indices in the best way possible (what results in a better RMSEA value etc.). However, the research is bound to important items that could not be left out.

Invariance test

The next step is to analyze the model on different aspects: Did experts with more experience in the construction industry answer all the questions significantly different in relation to the experts with less experience (same case with knowledge of the contract and no knowledge). If so, further analysis of only one **comprehensive** model within AMOS would not provide for

the best interpretable results. When the difference is significant, the two groups should be handled separate.

The best way to search for this difference is to make use of a tool that is developed by Statwiki ("Confirmatory Factor Analysis - Statwiki," n.d.). Statwiki developed this tool to map the group difference of certain items. To be able to start this analysis, four groups with the same dataset have to be made in AMOS: Experts with low experience (called ExperienceLow), experts with high experience (ExperienceHigh), experts with knowledge of NEC3 (KnowledgeNec3) and experts with no knowledge of NEC3 (NoKnowlegdeNEC3). There are 31 experts out of 94 that have low experience and 46 out of 94 that have knowledge of NEC3. The first two groups within AMOS get the grouping variable Expconstruction (Recoded experience variable) and the last two groups get the grouping variable KnowledgeNEC3. ExperienceLow and KnowledgeNEC3 get the value of 1 (for low experience and knowledge of NEC3 and ExperienceHigh and NoKnowlegdeNEC3 get the value of 2 (high experience and no knowledge of NEC3). The four groups are simulated by AMOS and one of the output is the critical ratios for difference between parameters. The coefficients estimates of all items will be compared pairwise (ExperienceLow with ExperienceHigh and KnowledgeNEC3 with NoKnowlegdeNEC3). The following table 4.15 is the output of the Statwiki tool, of the comparison of the items valued by experts with low experience in the construction industry and experts with high experience in the construction industry and knowledge of NEC3 and no knowledge of NEC3. This table shows on which item path the experts answered different. Gaskin (2013) argues that there should be at least one item of each factor that is not significantly different between groups to be able to proceed with the analysis.

Table 4.15
Pairwise comparison between low experience & high experience and Knowledge & no Knowledge of NEC3

	ExperienceLow		ExperienceHigh		
	Estimate	P	Estimate	P	z-score
ST2<---ST	0,515	0,453	0,768	0,000	0,361
ST3<---ST	5,269	0,284	0,529	0,000	-0,964
ST4<---ST	0,929	0,542	0,410	0,008	-0,339
PC3<---PC	1,436	0,000	0,444	0,013	-2,281**
PC2<---PC	0,932	0,002	0,363	0,038	-1,636
QP2<---QP	0,296	0,070	0,902	0,000	2,259**
QP1<---QP	0,275	0,074	0,530	0,000	1,145
QP4<---QP	0,153	0,156	0,461	0,013	1,432
OSN2<---OSN	1,159	0,038	0,838	0,000	-0,523
OSN1<---OSN	2,199	0,054	1,305	0,000	-0,744
OSN4<---OSN	1,462	0,053	0,791	0,001	-0,842
SBW2<---SBW	0,331	0,157	1,146	0,000	2,08**
SBW4<---SBW	8,376	0,634	0,882	0,000	-0,427
SBW3<---SBW	-0,443	0,065	0,816	0,003	3,47***

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

	Knowledge NEC3		NoKnowledge NEC3		
	Estimate	P	Estimate	P	z-score
ST2<---ST	0,814	0,003	0,872	0,000	0,186
ST3<---ST	0,742	0,005	0,509	0,002	-0,754
ST4<---ST	0,597	0,019	0,172	0,381	-1,323
PC3<---PC	1,210	0,023	0,709	0,000	-0,901
PC2<---PC	0,517	0,109	0,476	0,002	-0,117
QP2<---QP	0,692	0,000	0,484	0,002	-0,872
QP1<---QP	0,525	0,000	0,324	0,023	-0,964
QP4<---QP	0,630	0,000	0,250	0,074	-1,684*
OSN2<---OSN	1,129	0,030	1,025	0,002	-0,167
OSN1<---OSN	1,936	0,060	2,053	0,003	0,095
OSN4<---OSN	1,075	0,073	1,066	0,003	-0,012
SBW2<---SBW	1,190	0,016	0,903	0,037	-0,438
SBW4<---SBW	0,829	0,021	2,070	0,011	1,398
SBW3<---SBW	0,631	0,080	0,755	0,071	0,225

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Table 4.15 on the previous page shows in the last column the scores of the difference. Values of item paths with a *, ** or *** are significantly different. Evaluating the results should be done by looking at the values within one of the five factors. The table shows that there are no significantly different items within System-Based Trust. Planning & Control has two significantly different items, but one not significant item. All other factors show that there is at least one not significantly different item. The same analysis will be executed for 'Knowledge of NEC3'. The table concerning the knowledge shows that only QP4 is assessed significantly different in the groups. This means that the analysis can proceed and that the questions were invariant: a given item is interpreted in 'a conceptually similar manner by respondents representing different backgrounds' (Milfont & Fischer, 2010). However, this test concerns the paths between the items and the underlying factor. The difference in the answers of these two groups is more relevant when looking at the paths between the latent factors. For example the path between Planning & Control and the Overall Success of a Project to test the last two hypothesis of this research. This group difference is called 'multi group moderation' and is explored in paragraph 4.4.3.

As can be noted, the controller of NEC3experience is not used. A reason to check for invariance by means of the knowledge of NEC3 instead of the NEC3 experience is that the sample of respondents with NEC3 experience is too small. As a result, AMOS could not run the model on NEC3 experience because the observed variables are linearly dependent (there are only 13 respondents with NEC3 experience).

Common method bias

An important aspect for this research is the limitation concerning the fact that only self-report questionnaires are used. In self-reported questionnaires the respondents answers the questions without the interference of a researcher. They were asked about their feeling/attitude towards different aspects in the construction industry. The fact that multiple items are measured using multi-item scales within the same questionnaire leads to improper effects due to instruments instead of the items being measured. To be more specific, respondents are asked to answer the questions with their own perceptions on more items in the same survey. This could produce improper correlations among the items measuring the latent factors underlying the NEC3 contract due to response styles, social desirability and other effects which are independent from the real correlations among the factors being measured. This is called common method bias. To analyze the model on this bias, a common unobserved factor is implemented in the measurement model to capture the common variance among all items in the model. This is shown in figure 4.10 on the next page.
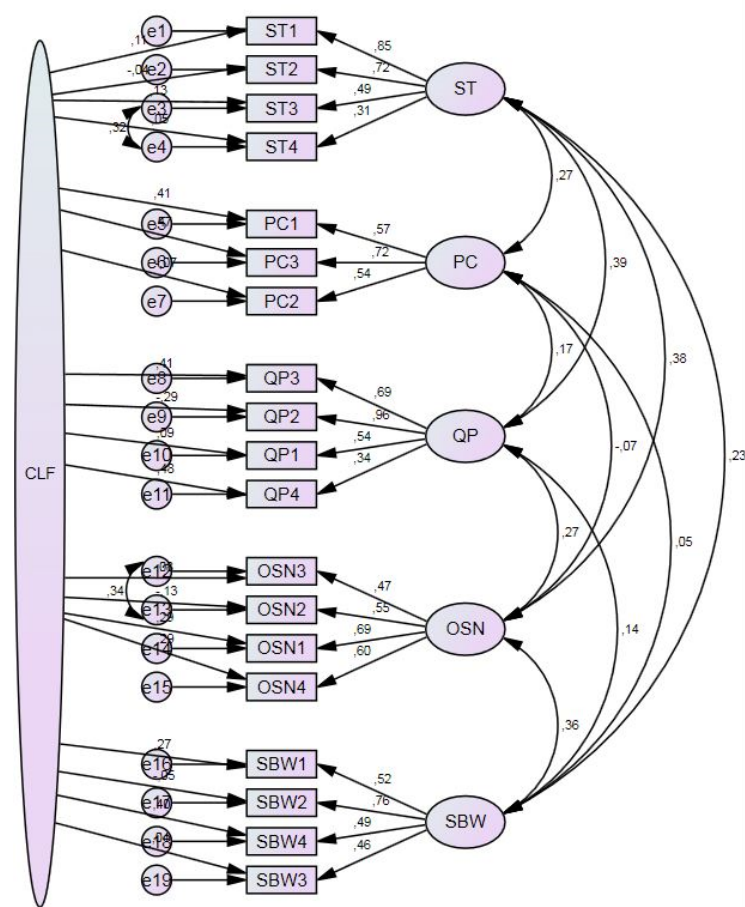
Figure 4.10 Common latent factor

When the standardized coefficients estimates of the model with a common unobserved factor (shown in figure 4.10 as a big oval factor on the left side) deviate more than 0,2 of the coefficients estimates without the common factor, this bias should be included in the final structural model.

The added factor resulted in the fact that four coefficient paths came close or exceeded the accepted difference of 0,2 (shown in table 4.16 on the next page in red).

Table 4.16

Difference between path coefficient estimates when using an unobserved factor that captures the common variance of all items

Standardized coefficient estimates: with common latent factor			Estimate	Standardized coefficient estimates; without common latent factor			Estimate	Difference
ST1	←	ST	0,850	ST1	<---	ST	0,894	0,044
ST2	←	ST	0,717	ST2	<---	ST	0,678	0,039
ST3	←	ST	0,494	ST3	<---	ST	0,498	0,004
ST4	←	ST	0,313	ST4	<---	ST	0,303	0,010
PC1	←	PC	0,570	PC1	<---	PC	0,667	0,097
PC3	←	PC	0,718	PC3	<---	PC	0,899	0,181
PC2	←	PC	0,542	PC2	<---	PC	0,391	0,151
QP3	←	QP	0,690	QP3	<---	QP	0,830	0,140
QP2	←	QP	0,956	QP2	<---	QP	0,653	0,303
QP1	←	QP	0,537	QP1	<---	QP	0,556	0,019
QP4	←	QP	0,338	QP4	<---	QP	0,442	0,104
OSN3	←	OSN	0,470	OSN3	<---	OSN	0,454	0,016
OSN2	←	OSN	0,551	OSN2	<---	OSN	0,445	0,106
OSN1	←	OSN	0,691	OSN1	<---	OSN	0,769	0,078
OSN4	←	OSN	0,598	OSN4	<---	OSN	0,663	0,065
SBW1	←	SBW	0,522	SBW1	<---	SBW	0,601	0,079
SBW2	←	SBW	0,760	SBW2	<---	SBW	0,592	0,168
SBW4	←	SBW	0,491	SBW4	<---	SBW	0,631	0,140
SBW3	←	SBW	0,456	SBW3	<---	SBW	0,427	0,029

This means that there is a common bias present in the questionnaire. To come to better results, the latent factor should be included in the final structural model which captures the common variance of all the items in the model. This means that the loadings of all the paths become different. The difference between the loadings with or without the common factor means that some of the variance being explained by the items is now being explained by the common factor. AMOS has a way to change these loadings into the loadings when using the common factor, without visible showing the common latent factor (CLF): Data imputation → regression imputation. This activity results in a final structural model with the adjusted loadings.

4.3.8 Final check before building structural model

Linearity

The overall success of a NEC3 project is assumed to be influenced by the other four factors System-Based Trust, Soundness of Business, Planning & Control and Quality Performance (SPSS states these factors as independent for this reason, because the mutually relation is omitted for a moment). The final structural model can only accurately estimate the relation between dependent factors when the relationships are linear in nature. SPSS is able to analyze this linearity of every relationship in the model. For example, to test the linearity of the independent variable System-Based trust and the dependent variable Overall success of NEC3 project the option 'Curve Estimation' can be used to see all the possible relations these two factors could have (linear, growth, exponential etc.). The goal is to see if the linear relationship is the highest relationship the two factors have and if the relation is significant. Appendix F table 6 shows the relationship of all 'independent' variables with the dependent variable. The column with the F-test can be used to see if the model fits the data well. The value of 'linear' in this column should be higher than the other values in the same column to be able to conclude that the relation between the two factors is indeed linear instead of for example exponential. Table 6 shows that for almost every independent factor the relation with the success of a NEC3 project is 'sufficiently linear' (this term can be used when the linearity is one of the highest values) and significant except for Planning & Control. The relationship between Planning & Control and Overall success of a NEC3 project is not significant and has not the highest F value for linearity. Because Planning & Control should be present in the final structural model due to important clauses classified under this factor, the limitation of this non-significant linearity should be accepted.

Multicollinearity

In the hypothesized model there are four factors that predict the overall success of a NEC3 projects. These four factors System-Based Trust, Soundness of Business, Planning & Control and Quality of the Performance are related (a correlation is never exactly 0), but sometimes they are highly related, what is assumed in this research. However, the correlation between the factors provides us with less information of the individual influence of each factor on the dependent factor (each independent factor could be partially predicted by the other independent factors). For example, when Soundness of Business and Planning & Control do not relate, each respondent provides valuable information on the relation between Soundness of Business and the Overall success of a NEC3 project. When Soundness of Business and Planning & Control do relate, the respondent's score on Soundness and Business indirectly gives information on his score on Planning & Control. This is called multicollinearity: The four factors share their linear relation with the dependent factor OSN (Overall success of NEC3 project). SPSS could determine the size of this co linearity by looking at the 'Variance Inflation Factor' of each factor. This VIF expresses a factor by which the variances of the other factors increases when including the particular factor. Gaskin (2013) argues that this value should below 10 (below 3 would be ideal), to have reliable results for the relation with the dependent factor OSN. The values of the VIF of all the four factors can be found in appendix F table 7.

This multicollinearity test was the last validating test of the model. There are some limitations regarding the relation between Planning & Control and Overall Success of a NEC3 project. However, this limitation will be included in the paragraph about the results of the SEM analysis.
Now that all tests are executed, the results of the SEM analysis will be examined.

4.4 Results of structural model

The last step for the SEM analysis is to transform the measurement model in figure 4.9 in a structural model (with the imputed dataset to use the adjusted loadings). SPSS AMOS permits to transform the measurement model by dragging the factors in a way that the structure is the same as the hypothesized model. It was hypothesized that the four factors System-Based Trust, Soundness of Business, Planning & Control and Quality Performance all have an influence on the overall success of a NEC3 project. Alongside these relations, there are three other hypothesized relations namely System-Based Trust influencing the Soundness of Business, Soundness of Business influencing the Planning & Control and Planning & Control influencing the Quality of Performance. When all these relations are mapped, SPSS AMOS is able to run the model.
The loadings of each item on the latent factor and the loading of each latent factor on the overall success of a NEC3 project is presented in figure 4.11.
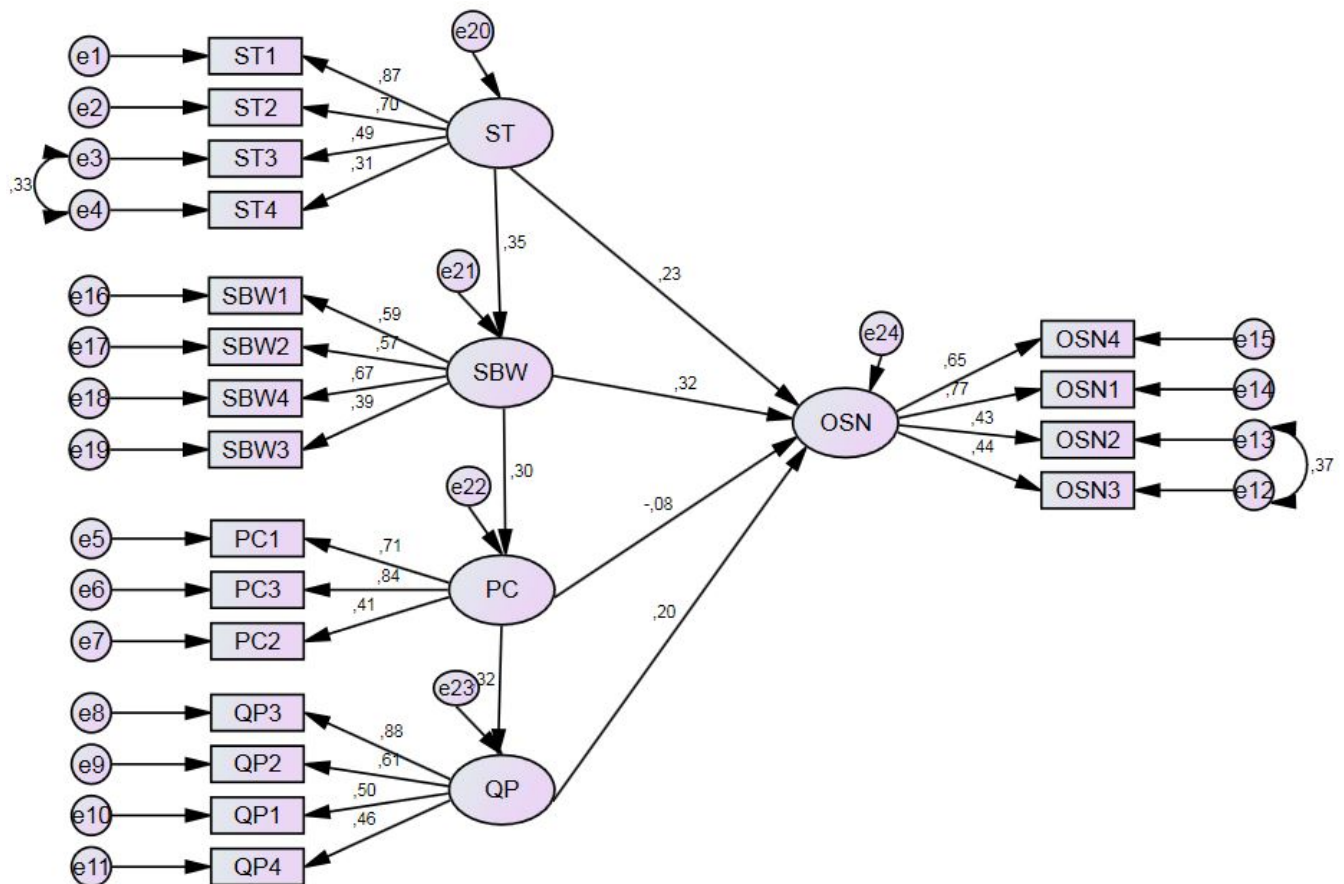
Figure 4.11
Coefficients estimates of Structural model

Figure 4.11 depicts the final model with also the non-significant paths. The loadings (correlations) of each item on the factor and between the factors are also presented in table 4.17 in the second column 'standardized coefficient estimates'.

Table 4.17
Coefficients estimates of Structural model

Standardized coefficient estimates of the SEM			
Path	Standardized coefficient estimates	Standard effort of estimates	Definition items
SBW ← ST	0,35	0,147	
PC ← SBW	0,30	0,230	
QP ← PC	0,32	0,131	
OSN ← ST	0,23	0,109	
OSN ← SBW	0,32	0,142	
OSN ← QP	0,20	0,074	
OSN ← PC	-0,08	0,076	
ST1 ← ST	0,87	0,246	Clearly defined job task
ST2 ← ST	0,70	0,175	Clearly defined contract documents
ST3 ← ST	0,50	0,149	The contractor's qualification level
ST4 ← ST	0,31	0,154	Implementing a transparent communication system
PC1 ← PC	0,71	0,257	Early warning system
PC3 ← PC	0,84	0,217	Flexibility in the critical path of the planning
PC2 ← PC	0,41	0,164	A very detailed work specification
QP3 ← QP	0,88	0,314	Quality of the control of risk programs
QP2 ← QP	0,61	0,146	Detailing in the safety record
QP1 ← QP	0,51	0,125	Tender quality (sufficient time to profile each tenderer)
QP4 ← QP	0,46	0,134	Joint goal setting (objectives)
OSN3 ← OSN	0,44	0,163	On time delivery
OSN2 ← OSN	0,43	0,267	Cost savings
OSN1 ← OSN	0,77	0,561	Controllability up to project delivery
OSN4 ← OSN	0,66	0,322	Good added value (quality)
SBW1 ← SBW	0,59	0,296	Technical expertise
SBW2 ← SBW	0,57	0,263	Attitude defects liability (defects date)
SBW4 ← SBW	0,67	0,263	Clearness of risk allocation policy
SBW3 ← SBW	0,39	0,227	Close collaboration

Table 4.17 shows the lowest relations in red and the highest relations in green. The bold number highlight the relation between the latent factors in the model. These outliers will be discussed in paragraph 4.4.2.
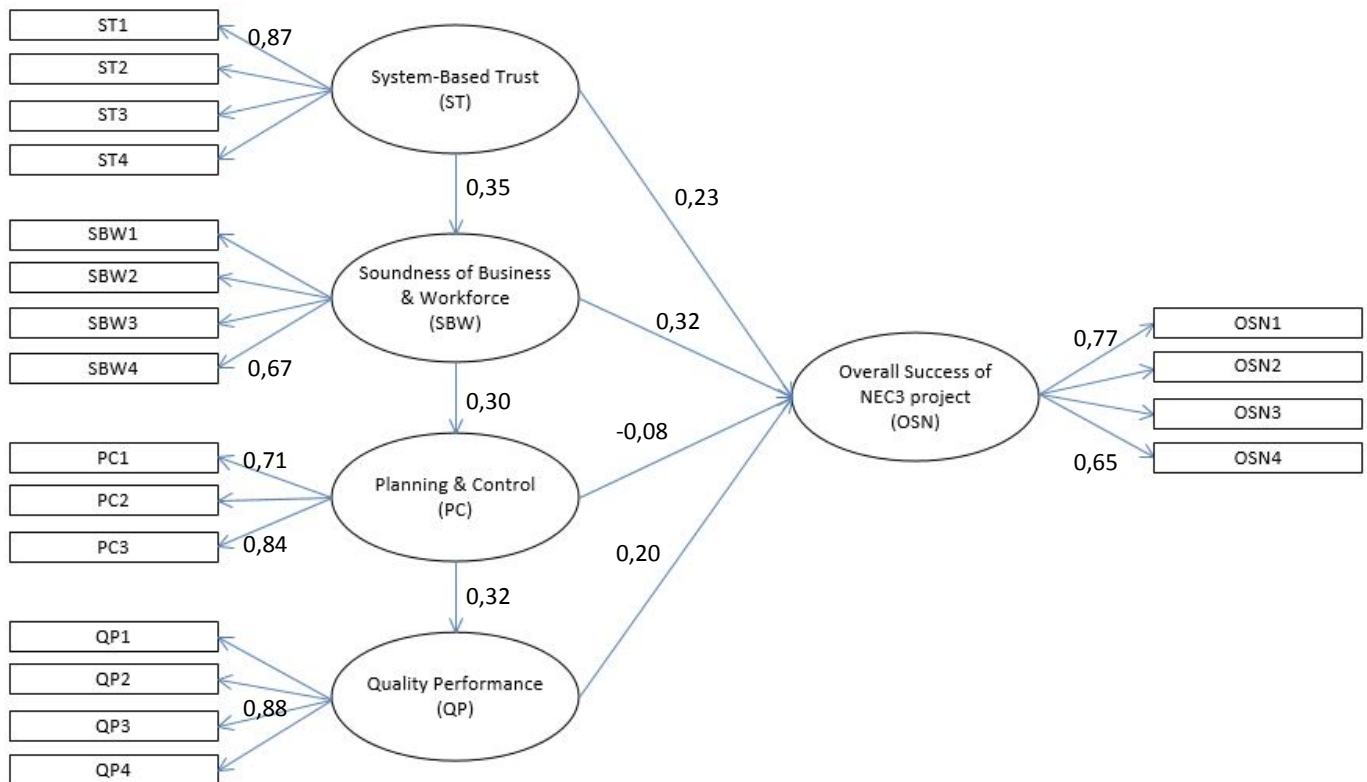
Figure 4.12
Final structural model with items presented in numerical order (hypothesized model)

Figure 4.12 represents the highest loadings between the items of the contract and the underlying five factors. This figure represents the same model as in figure 4.11 but the items are reversed in initial numerical order as the hypothesized model (SPSS AMOS displays the items in the order of the magnitude of the loadings). "

4.4.1 Loadings/correlations between latent factors

The model presented in figure 4.12 shows seven relations between the latent factors. These seven relations are hypothesized in paragraph 4.3.4. The model will be tested on the basis of the formulated hypotheses:

Hypothesis 1)
The success of a NEC3 project improves, when the System-based trust (ST), the Soundness of Business and Workforce (SBW), Planning & Control (PC) & the Quality Performance (QP) are becoming at a higher level.

Hypothesis 2)
The Soundness of Business and Workforce (SBW) improves when the System-Based Trust (ST) due to the contract is improved.

Hypothesis 3)
The Planning & Control becomes (PC) of a NEC3 project improves when the Soundness of Business and Workforce (SBW) is improved.

Hypothesis 4)
The Quality of the project performance (QP) of a temporary project improves when the planning and control (PC) of a NEC3 project is improved.

Looking at figure 4.12, the relations between the latent factors are less strong than expected. A reason for these low correlations is the sample size (SPSS AMOS needs a larger sample size to analyze the values with respect to one another. Another reason for the low correlations is that it was not clearly mentioned in the questionnaire that it was very important to value the items with a high deviation relative to each other. For example, the results are less reliable when someone values all items as 'neutral' or as 'important'. Considering these two 'limitations', the values of the relationships should be handled carefully and in proportion to the quality of the dataset.
Values greater than 0,30 are perceived to be a good relation between factors.

The first hypothesis is thus invalidated by means of this information: the relation between Planning & Control and the factor Overall Success of a NEC3 project is weaker than expected. This means that the experts did not see the relation between the three items of Planning & Control and the four items of the Overall Success of a NEC3 project as important as the literature suggested (Davis, 2014; Doloi et al., 2011). However, this does not mean that the three items of Planning & Control in itself are not important. The other three relations respectively 0,23; 0,32; 0,20 are sufficiently significant .

The second, third and fourth hypotheses are valid because the loading between System-Based Trust & Soundness of Business is higher than 0,3. The same applies to the relations mentioned in hypotheses 3 & 4.

4.4.2 Loadings/correlations between items and factors

The hypothesis related to the relations between the underlying latent factors, but the relations of the several clauses in NEC3 with the latent factors tells us also something about the perceived importance of the clauses.
Correlations greater than 0,65 between items and factors is perceived to be a good relation (Gaskin, 2013). Figure 4.12 highlights the loadings that exceed the value of 0,65. The corresponding table 4.18 provides for the definitions of the items with the highest values.

Table 4.18
Items with the highest correlation with the latent factors

Variable name	Definition	Correlation
ST1	Clearness defined job tasks	0,87
SBW4	Clearness of risk allocation policy	0,67
PC1	Early warning system	0,71
PC3	Flexibility in the critical path of the planning	0,84
QP3	Quality of the control of risk programs	0,88
OSN1	Controllability up to project delivery	0,77
OSN4	Good added value (quality)	0,65

An interesting part is that the RM tools of NEC3 (early warning system and the strict programme) have the highest value. This means that the experts have acknowledged the positive contributions of these clauses. However, when looking at table 4.17 the transparent communication system ST4 is valued lower than expected.

In the conclusion of the literature review is was mentioned that articles were contradictory when talking about project success: The review states that ''Turner & Zolin (2012) argue that the success of a project has little to do with costs, quality and time but more with the successful project planning and stakeholder engagement (satisfaction), performance and achievement of the goals, while Akintoye & MacLeod (1997), Davis (2014), Doloi et al. (2011) conclude that the delivery of a project on time, at cost and with the desired quality are definitely important aspects of the success of a project.''
The SEM analysis shows that the experts valued the controllability up to project delivery and the added value of the project higher than the cost savings and the on time delivery.

4.4.3 Multigroup moderation (group differences)

One goal of this research is to evaluate the difference in the valued items by the experts by means of their experience in the construction industry and their knowledge of the contract. Two hypotheses were drafted with respect to these differences:

Hypothesis 5
Experience in the construction industry moderates positive effect of Planning & Control (PC) on the Overall success of a NEC3 project (OSN).

Hypothesis 6)
Knowledge of the Contract moderates positive effect of Planning & Control on the Quality of the Performance (QP) and on the Overall project success of a NEC3 project (OSN).

The scientific designation for evaluating this difference in the given answers by experts with high experience in the construction industry in relation to the experts with low experience is called multi group moderation. The same applies to the knowledge of the experts on the contract. A way to analyze the significant difference is to compare the coefficient estimates (loadings) of the groups in AMOS (the same way as in paragraph 'invariance test', but now for the structural model) by means of the critical ratio's for group differences table in AMOS. As explained in 'invariance test', Statwiki developed a tool that executes this analysis by means of excel. The output of this analysis is shown in table 4.19 and 4.20. The last column of these tables shows z-scores, whereby high values represent the significant difference between the groups.

An important remark is that negative loadings suggest that the loadings of the High Experienced ones are significant lower than the Low Experienced ones. It is the way how the tools works (for example, the negative z-scores become positive when the two columns are reversed).

Table 4.19
Significant differences in the given answers by experts with low and high experience in the construction industry

			ExperienceLow		ExperienceHigh		
			Estimate	P	Estimate	P	z-score
SBW	←	ST	0,120	0,437	0,289	0,002	0,935
PC	←	SBW	-0,156	0,508	0,008	0,959	0,573
QP	←	PC	0,664	0,010	0,211	0,287	-1,396
OSN	←	ST	0,195	0,184	0,240	0,000	0,278
OSN	←	SBW	0,354	0,013	0,254	0,000	-0,626
OSN	←	QP	-0,003	0,962	0,158	0,000	2,075**
OSN	←	PC	-0,285	0,009	-0,074	0,196	1,723*
OSN	←	Workfield	-0,001	0,984	-0,045	0,034	-1,039

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Table 4.20

Significant differences in the given answers by experts with or without knowledge of the NEC3 contract

			KnowlegdeNEC3		NoKnowledgeNEC3		
			Estimate	P	Estimate	P	z-score
SBW	←	ST	0,292	0,012	0,116	0,304	-1,091
PC	←	SBW	-0,168	0,321	0,052	0,810	0,803
QP	←	PC	0,699	0,003	0,104	0,600	-1,915*
OSN	←	ST	0,235	0,009	0,355	0,000	0,874
OSN	←	SBW	0,223	0,019	0,353	0,002	0,884
OSN	←	QP	0,123	0,010	-0,002	0,980	-1,574
OSN	←	PC	-0,188	0,027	-0,204	0,007	-0,139
OSN	←	Workfield	-0,010	0,721	-0,018	0,561	-0,186

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Hypothesis 5 is considered valid because experts with high experience in the construction industry valued the importance of Planning & Control on the Overall success of a NEC3 projects significantly higher than experts with low experience (shown in table 4.18 path OSN ← PC. As an addition, the relation between the Quality Performance and Planning & Control and the relation between Quality Performance and the Overall Success are also valued significant different between the two groups.

Hypothesis 6 is partially valid, because the relation between Planning & Control and Quality Performance is valued significantly different between the two groups 'Knowledge of the contract' and 'No knowledge of the contract' (shown in table 4.20 path QP ← PC).
And again, the negative loadings mean that the columns should be reversed: Experts with knowledge of the contract acknowledged the importance of the relation between the items of Planning and Control and the items of the Quality of the Performance more than the experts with no knowledge of the contract. However, the relation between Planning & Control and Overall success of a NEC3 projects is valued almost the same by the two groups.
Instead the experts with knowledge of the contract did acknowledged the importance of the relation between the Quality of the Performance and the Overall success more than the experts without knowledge.

4.5 Discussion

The case study on the ICC is examined and the SEM analysis on the five factors with their 19 NEC3 components is processed to give an overall view on the benefits of this new contract.
A few remarks have to be made before stating the conclusion of the overall thesis: at the starting point of this thesis the main focus was investigating the interrelationship between RM and SM and the NEC3 contract was of secondary importance. However, during the course of this thesis the contract became more and more important (also for HEVO, TBI and the building industry) also because of the first successful NEC3 project in the Netherlands what resulted in a shift to address the contract as the main goal of this thesis. And because of the unfamiliarity of the contract in the Dutch industry is was risky questioning Dutch experts on the unknown contract.

The questions were asked in a way that the respondents did not need knowledge of the contract (by providing background information), but this may cause that the results are of less quality. Releasing the questionnaire took a lot of effort because of the high threshold that the questionnaire was in English. Eventually also the sample size influenced the results: initially 135 experts filled in the questionnaire, but 34 people did not use the submit button what resulted in invalid questionnaires. This should be stated more clearly in future research. Another point of improvement is that the questions about the personal information of the respondents should be asked differently so that they would be more useful as mediators. Question 12 of the questionnaire has been left out of the analysis because the items in this question did not serve a purpose in the structural model (the first idea was to subdivide them under the four items of 'Overall project success of NEC3' and then take the medium).

The objective of the questionnaire and the SEM analysis was to explore different aspects of the NEC3 contract which were classified under four unobserved 'latent' factor. To be able to answer one of the research questions 'What are the success factors of NEC3 in the Netherlands given the success factors in the UK', Dutch experts in the construction industry valued the different clauses on their influence on the project success. At first there should be concluded that the correlations between all factors in the final model are relatively small for drawing good conclusions. A good SEM analysis has a preference for values higher than 0,5. This limitation of the analysis has to do with the small sample size: results are more reliable when the sample size is at least five times as large as the number of items that have to be valued and the minimum amount has to be of high quality (quality that is usable for SEM). The results of this research should be reviewed in perspective: this research required at least 90 questionnaire of high quality for executing a SEM analysis. However, only 94 valid questionnaires were useful for conducting the SEM analysis of which not all of high quality. Another reason for the low correlations is that it was not clearly stated that high deviations in the valued items was needed to get better results. For this research a correlation between the items and the latent factors higher than 0,65 (normally above 0,7) is perceived to be a strong relation and the correlation between two latent factors higher than 0,3 (normally above 0,5) is perceived to be a strong relation. Another important remark is that articles are inconclusive when talking about the relations between the factors. Correlation, relation, loading, coefficient estimate, weights are all the same designations for the relations between the factors.

At last the introduction of the maturity model should be discussed: the introduction of the maturity model could cause confusion because the criteria mentioned in this model differ from the factors named in the thesis. Evaluating the contract by means of the adjusted maturity model on trust was purely to assess the contract with a scientific verified model. Eventually the criteria were linked to the factors.

5 Conclusion

5.1 Conclusions regarding the case study and the SEM analysis

Paragraph 4.3.4 Framework for SEM was closed with the preparation of six hypothesis. This research follows the steps of the empirical cycle of research by verifying hypothesis and creating new scientific knowledge. In the case of this research, a better understanding of the British NEC3 contract is being pursued. The literature review provided several clauses of the contract and common used project management tools in the direction of RM and SM. These last two concepts were elaborated because the NEC3 contract is known for innovative aspects with respect to these tools. The whole literature review served to answer the first four research questions of this thesis as stated in the conclusion of the review. However, knowledge of the contract gained by existing literature does not give an overall picture of the actual implementation in the Dutch construction industry because of cultural differences, different laws and different manners of operation in the construction industry. The review stated that future research should not neglect the differences accepted project management tools because literature tends to use universal SM & RM tools. When the differences are taken into account, the results will be more beneficial. The research model tried to investigate the difference by introducing a case study of the British contract in the Dutch culture. The goal of the case study and the SEM model was to answer the last two research questions of this thesis:

5) What are the success factors of NEC3 in the Netherlands given the success factors in the UK?
6) What are the perceived advantages of NEC3 in the interrelationship between RM and SM components?

These two research questions also relate to the mentioned literature gaps in the field of RM, SM and NEC3 stated in the conclusion of the literature review:

❖ Further investigate the contract type influencing project-specific contexts in the Netherlands compared to Great Britain;
❖ Model the interrelation between RM (planning and control), SM (trust, soundness & performance) in NEC3 to see how NEC3 leads to project success.

An important note should be made first before starting analysing the findings. The initial main goal of this research was to evaluate the importance of RM and SM and the interrelation between these two project management concepts. This resulted in chapter 3.5 and 3.6. During the process of this research the focus shifted from the main goal RM and SM to the NEC3 contract with its RM & SM tools. However, these chapters investigated used RM & SM tools over the last decade. This helped further research to put the tools of NEC3 in perspective with the current practiced project management tools.

5.1.1 Case study

The NEC3 contract was evaluated in the literature review and in chapter 4 by means of seven criteria that were part of a maturity model on the trust level between the stakeholders in a NEC3 project and the SEM analysis. Assessing the NEC3 contract by means of the maturity model was executed by looking at the contract in general (NEC3 books) and by introducing a case study.
This paragraph will draft conclusions concerning the chapter on NEC3 and the case study on ICC which was assessed with the maturity model.

Findings of the case study were that the implemented transparent communication system (SharePoint called '4Projects) that was used during the project provided for good added value. Also because the construction of the ICC building was the first project managed by NEC3, the procurement stage was very extensive. In this stage trust was created with the remaining participants.

Subcontractors and suppliers are purchased together with the client during the procurement what is innovative for the Dutch building industry (Veldhuizen, 2015). Paragraph 3.6.1 stated that there is limited research available on the trust development between a contractor and subcontractors (Manu et al., 2015). The contract ensures that both the client and the contractor have a say in the purchase of subcontractors. De Kleijnen (2015) concluded that the trust between the parties is higher in this manner.
Also the clear risk allocation during the whole project was very easy to understand by the stakeholders. De Kleijnen (2015) argued that the gain/pain mechanism is a very strong incentive for all the involved stakeholders to seek cost efficient solutions and that this incentive encourages collaboration and openness.

A great advantage of the NEC3 contract relative to the UAV and the UAV-GC is that the UAV and UAV-GC impose many additional project-specific conditions through the tender specification which are not transparent. In other words, the NEC3 brings together all the separate arrangements in the Netherlands (UAV-GC with the DNR with common used conditions in general provisions of specifications).

The target principle is often used in the Netherlands, but most of the time project specific arrangement have to be organized. In NEC3 the concept of the target principle is matched with other part of the conditions like RM and the purchase of subcontractors.

Important other conclusions of the case study regarding the trust level in a NEC3 project are:

❖ Mutual trust. The British contract records that mutual trust has to be present in the collaboration. For British concepts this was very new. However, Dutch companies have been working according to the principle of reasonableness and fairness for many years and most of the time an agreement will not be established when there is not trust involved. Also paragraph 4.3.3 Case study concluded that trust is already enhanced in the procurement stage, because without trust a contractor will not be chosen. Reporting

mutual trust in the contract in the Netherlands could be unnecessary or even be a suspicious concept.

The question that arose during the review if the clause 10.1 on Mutual trust will work in the Netherlands because of cultural differences is in this way elaborated.

❖ The early warning system ensures that the contractor feels an incentive to warn stakeholder of possible risks or problems within a certain period of time, because otherwise the contractor is not entitled for compensation events (payments);

❖ Compensation events involve the concept of 'meerwerk'. The contract describes the process of handling these events. The agreed contract price is the target price raised with the total of compensation events.

❖ The programme: every detail has to be laid down. The literature review on NEC3 stated that information ranging from which bolt should be used to the 'time risk allowance', is formulated in the procedures of the project. In NEC3 everything evolves around process management, planning and control (Roijers, personal communication, December 21st, 2015). When option C is applied, the contractor provides information which shows how each activity on the Activity Schedule relates to the operations on each programme he submits. When the contractor fails to submit a realistic programme in the contract data then one quarter of the price for work done to date (see glossary) is retained in assessments of the payment. The programme provides also a cash flow forecast, called the 'cost loaded programme' that indicates how cash will be spent over time on a project. It gives weight to schedule components and helps to measure project status.

❖ Risk register: the literature review stated that Dikmen, Birgonul, Anac, Tah, & Aouad (2008) argue that the future needs a shift from 'management of adverse effect' to learning from risks to eliminate risk on beforehand. The NEC3 contract is flexible in handling risk by continuous improvement of the risk register.

❖ Open book system; the target contract is based upon a transparent open book system. When the target is exceeded, the division of the exceedance is laid down in the contract between the client and the contractor. Also inspections and report that have to be submitted are laid down in the contract.

❖ The pain/gain mechanism is a result of the open book system and an incentive for all the stakeholder to work cost efficient.

❖ Notification procedure: Core clause § 13.1 in chapter 1 'General' states that the stakeholders should communicate in a form which can be read, copied and recorded (Eggleston, 2015, p. 96). This suggest that it should be in writing. Communication between the stakeholders involves instructions, certificates, submissions, proposals, records, acceptances, notifications and replies. Decisions are not included in this list but this is an unwritten rule that is should be included in the clause. Evans (2013) states that an increased administrative burden will be created when these communication rules and procedures are strictly followed. Every notification has to be given separately and in writing.

All these innovative concepts offer a new form of collaboration between stakeholders. Except for clause 10.1 'Mutual trust' is a little bit vague for Dutch concerns, the other clauses are definitely good replacements for the UAVG-GC

5.1.2 SEM

The purpose of the SEM analysis was to evaluate if the experts indeed indirectly detected five underlying factors 'System-Based Trust, Soundness of Business, Planning & Control, Quality Performance and Overall Project Success of NEC3 project' by answering 19 questions about clauses in the contract. Also the importance of these 19 items was analysed to see how experts in the construction industry   Knowledge of the contract was not a requirement (important background information was provided). The dataset was analysed in SPSS 22, Excel and SPSS AMOS.

The model fit of the dataset was investigated in paragraph 4.3.7 Confirmatory factor analysis by Goodness-Of-Fit measures. These measures concluded that the model was sufficiently fit for analysing the dataset in SPSS AMOS (last column of table 5.1).

Table 5.1
Goodness-Of-Fit measures in AMOS 20.0

GOF measures	Recommended level of GOF	Final SEM model	Conclusion
Degree of freedom	1-2	1,683	Good fit
Goodness-Of-Fit index (GFI)	0-1	0,805	Good fit
Adjusted Goodness-Of-Fit index (AGFI)	0-1	0,736	Fit
Root mean square error of approx. (RMSEA)	<0,05-0,1(no fit)	0,086	Basically fit/No fit
Comparative Fit Index (CFI)	0-1(good fit)	0,780	Fit
Normal Fit Index (NFI)	0-1 (good fit)	0,610	Fit
Incremental Fit Index (IFI)	0-1 (good fit)	0,794	Fit

The results of the analysis were tested against 6 hypothesis stated in paragraph 4.3.4 and also presented below. Four of them were declared valid, hypothesis 6 was partially valid and hypothesis 1 was not valid due to the negative correlation between Planning & Control and Overall Success of NEC3 project. This means that the expert did not acknowledge the relation between the items of Planning & Control and the Overall Success of NEC3. This contradicts the assumptions made in the review by Akintoye & MacLeod (1997), Davis (2014), Doloi (2011) in paragraph 3.7, that the underlying factor Planning and Control has a strong relation to the Success. The reason for this negative correlation is hard to underpin: the separate items of PC and OSN are highly rated. A reason for the negative correlation was found in the quality of the dataset and the way of questioning.

Hypothesis	Conclusion
1) The success of a NEC3 project improves, when the System-based trust (ST), the Soundness of Business and Workforce (SBW), Planning & Control (PC) & the Quality Performance (QP) are becoming at a higher level.	**Not valid**
2) The Soundness of Business and Workforce (SBW) improves when the System-Based Trust (ST) due to the contract is improved.	**Valid**

3) The Planning & Control becomes (PC) of a NEC3 project improves when the Soundness of Business and Workforce (SBW) is improved.	**Valid**
4) The Quality of the project performance (QP) of a temporary project improves when the planning and control (PC) of a NEC3 project is improved.	**Valid**
5) Experience in the construction industry moderates positive effect of Planning & Control (PC) on the Overall success of a NEC3 project (OSN).	**Valid**
6) Knowledge of the Contract moderates positive effect of Planning & Control on the Quality of the Performance (QP) and on the Overall project success of a NEC3 project (OSN).	**Partially valid**

Hypothesis 2, 3 and 4 relate to the relation between the latent factors. The results in paragraph 4.4.1 confirm that the prior assumption that mutual trust, a sound business, a good programme and the quality of the performance of a project are important factors and are influenced by each other. For example, when System-Based Trust is not present in the project team, the business is not as sound as expected.

Table 5.2
Items with the highest correlation with the latent factors

Variable name	Definition	Correlation
ST1	Clearness defined job tasks	0,87
SBW4	Clearness of risk allocation policy	0,67
PC1	Early warning system	0,71
PC3	Flexibility in the critical path of the planning	0,84
QP3	Quality of the control of risk programs	0,88
OSN1	Controllability up to project delivery	0,77
OSN4	Good added value (quality)	0,65

Table 5.3
Items with the lowest correlation with the latent factors

Variable name	Definition	Correlation
ST4	Transparent communication system (open book)	0,31
PC2	A very detailed work specification	0,41
SBW3	Close collaboration	0,39

Table 5.2 shows us that there are 7 items of the questionnaire that were assessed with a high value. These results contradict the studies of Akintoye & MacLeod (1997), Davis (2014), Doloi et al. (2011) who conclude that the delivery of a project on time and at cost are definitely important aspects of the success of a project.

These two items in this research (OSN2 and OSN3, shown in figure 4.11) were assessed lower than the items controllability and added value (OSN1 and OSN4).

NEC3 attaches great importance to the process of the project (expressed in the detailed programme clauses) and the high value for item QP3 suggest that the respondents agree with this importance. Also the high values concerning the RM tools of NEC3 such as the early warning system, clearness of risk allocation and flexibility of the planning (constant revision of the programme) suggests that the experts found these principles an added value for project success.

Table 5.3 shows us the lowest correlations between the items and the latent factors. Noteworthy is that the transparent system of the project (ST4) is valued very low. This contradicts the findings of the case study that the transparent open book system resulted in good added value but reinforces the assumption made in paragraph 4.3.6 in 'iteration to come to a clean pattern matrix. A reason for contradiction is that the Dutch construction industry is somewhat conservative in exposing their accounts. Another contradiction is that the case study was very satisfied with the detailed programme of the whole project, where everything should be laid down in detail and every tiny change should be in a separate notification. Respondents valued PC2 'a very detailed work specification' rather low. The reason for this could be that they fear the administrative hassle.

5.2 NEC3 summarized in a nutshell

Paragraph 5.1.1 and 5.1.2 served to explore the success factors of NEC3 in the Netherlands given the success factors in the UK, which is the fifth research question of this research. Research question 6 concerns the perceived advantages of NEC3 in the interrelationship between RM and SM components. The only possible answer to this **question** is that the target contract within NEC3 is a new form of collaboration where the contractor must design and build for a target price (including compensation events) and must provide for an insight in all the incurred expenses on the basis of an open book. Undershoot and overshoot of the target price will be shared according to a distribution formula. The interrelation between SM tools and RM tools in this principle is that the stakeholders are obliged to give early warnings to reduce cost overruns (RM) and to work closely with each other to improve the risk register at risk reduction meetings (RM) and the fact that all the involved stakeholders purchase the subcontractors together (SM) and are obliged to work according to the open book system (SM), trust in the system is enhanced because the withholding of business is not possible. This stimulates collaboration, transparency and soundness.

This automatically also answers the main research question:

How does NEC3 improve the interaction between multiple stakeholders and the problem solving procedure in complex building projects?

5.3 Implications and recommendations

This research aims to create awareness of the advantages and disadvantages of the British NEC3 contract. The contract could definitely bring new insights in the Dutch construction industry in the field of RM and SM. The structure of the contract is designed in a way that the contract could serve in different countries with different policies, however, the extensiveness and the amount of available information of the contract is a high threshold for many people, especially because it is in English. An implication of this threshold is that the Dutch people are not willing to invest a lot of time in discovering all the items of the contract. One way to tackle this problem is to designate an English project director who has all the knowledge of the contract and is able to share his knowledge with the Dutch construction industry (in the case of the ICC project). The other way is that the NEC3 contract (especially the target contract) will be translated in Dutch.

Another important remark is that the NEC3 family was very innovatory for the foreign countries, but many aspects of the contract were already established in the Dutch industry. An implication of introducing the NEC3 is that NEC3 is a concept that is applicable to every specific building project. This means that no additional project specific conditions are needed (what is the case with UAV-GC, when stating the general provisions of the project) because of the uniformity. All the general provisions of the NEC3 contract are transparent and uniform.

NEC3 is certainly recommendable when the Dutch building industry is seeking for innovative concepts, however it remains difficult to compare different cultures because of their perceptions and behaviors.

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Appendices

Appendix A - The role of HEVO in the building process

HEVO, active in the field of housing advice and project management, guides the client in the realization of housing and development goals. The client determines the way in which HEVO carries out the project: the collaboration that fits the organization and the task the most. In recent years HEVO provides more and more integral project management, including 100 percent guarantee on time, budget and quality. This is called the IPM model; looking at the total process with multidisciplinary knowledge and experience in integrated projects. In this case HEVO operates as delegated commissioner, where HEVO works alongside the client and fulfils its role as project manager and thereby directs all parties who are traditionally involved in the building process. The client still has contact with all involved stakeholders. HEVO will contract the designing parties and the executing parties (HEVO, 2014). This collaboration is often conducted in complex projects for government & healthcare facilities.

figure A
) Calculated risks that can
emain in place
) Prevention is desirable
) Prevention is a must
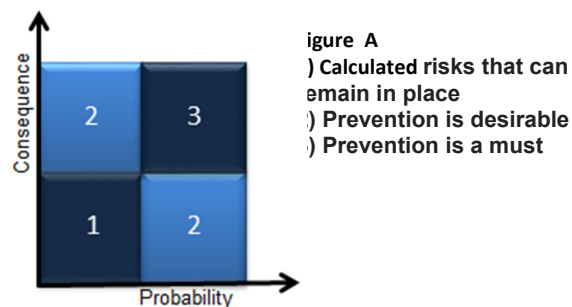
In contrast to the traditional Design & Build contract, the clients' influence during the process will be guaranteed. The client has only one contact person, gets accountable guarantees for the aspects quality, schedule and budget and has progressive insight in the project. This IPM model can be seen as a traditional construction management model, supplemented with RM, tender management, contract management and cost management. The difference between the traditional collaboration is that all involved stakeholders are managed by HEVO.

HEVO attaches great importance to RM in these collaborations and defines risks as follows: Risks – effect = opportunity x consequence. A risk is greater when the probability of occurrence and the consequences of occurrence are greater. A major consequence combined with a minimal probability is generally not considered to be important, just as a high probability with minimal consequences (figure A). Depending on the probability and the consequence a risk can be addressed in four ways (HEVO, n.d.):

1)   Prevention: eliminate one or both of the factors probability and consequence;
2)   Reducing: weakening one or both of the factors probability and consequence;
3)   Outsourcing: The placing of risks with the insurer;
4)   Accept: Only applicable when the probability or consequences are very low.

HEVO focuses namely on the external risks involved in a building project, when they operate according to the IPM model. The goal of further research is to find out if the NEC3 contract could replace the current UAV-GC contract which is applicable to the IPM model.

Appendix B - Questions for experts with knowledge of NEC3

Explain research

Explain setup (goal, duration, question setup)

Introduction

1. Were you involved in the procurement of a NEC3 project? Yes, proceed with question 3, No, proceed with question 2.

2. Do you have knowledge of the NEC3 contract but no experience with a NEC3 project? Yes, proceed with question 6.

Questions regarding trust during procurement

The first questions concern the procurement of the contract.
An important aspect to search for the best contractor is to find out if the tenderers have the following competences: Capability to contribute towards collaborative working, relevant experience and a forward thinking culture, project management ability, target cost contracts and pain / gain mechanism.

3) Were the tender stages of the project sufficient to determine the Contractor and the other tenderers' trustworthiness (ability, integrity, predictability and reliability) to carry out the project?

Clause 10.1 states that the Client, the contractor, the project Manager and the Supervisor shall act in a spirit of mutual trust and co-operation.
4. Did this clause have an influence on the behavior of the Client, the Project Manager and the Contractor?

5. Do you think that this clause will always work in the Netherlands?

The Contract Documentation is subject to the Scots law and is a mixed legal system containing civil law and common law elements and includes the principle of good faith.

6. Does this principle of good faith in Scots law have an influence on the behavior of the Client, the Project Manager and the Contractor in the Dutch construction industry in your opinion?

7. Do the joint project objectives with regard to the relationship have an influence on the behavior of the Client, the Project Manager and the Contractor?

Questions regarding objectives (if no involvement in NEC3 project, proceed with question 9)

This question deals with the project objectives. Project objectives are aligned with regard to the project results, the procedures and the relationship.
8. Do the Client, the Project Manager and the Contractor comply with these project objectives up to now?

Option M (X15) is an option to include in the contract which limits the contractor's liability for his design to reasonable skill and care. In other words, the design does not have to be on the basis of fitness for purpose.
9. Why should a project manager or client choose to include this Option?

Questions regarding communication (if no involvement in NEC3 project, proceed with question 15)

Communication is also covered in NEC3 ECC in clause 13. Communication must be in a form which can be read, copied and recorded, writing must be in English, the period of reply is two weeks, and a notification must be communicated separately. In addition, this clause sets out rules for replying to communication and the issuing of certificates.

10. Do the involved parties comply with this clause? (Does it work well or are there any problems?

Besides formal communication, informal communication is also very important in projects.
11. Do you think that the client, the project manager and the contractor also have informal contact with each other?

Questions regarding problem solving

Clauses 60-65 in the NEC3 ECC deal with Compensation Events. The Project Manager plays an important role in the CE procedure. The occurrence of disputes may be referred to the Adjudicator.

12. Do the Client, the Project Manager and the Contractor comply with these clauses up to now? (Do they work well or are there any problems?) (Impartiality project manager, a lot of compensation events)

13. What do the parties do during the project in order to solve problems by amiable agreement? (16.1 Early warning/10.1 Collaboration/Mutual help?)

14. Do the Compensation Events have an influence on the trust level between the Client and the Contractor?

Questions regarding risks if no involvement in NEC3 project, just answer question 16)

This question covers the risk allocation. A workshop was held to identify and to evaluate contract risks, to allocate risk responsibility and ownership, and to quantify defined and overall risk costs. According to clause Z11, the Client risk register is developed jointly between the Client and the Contractor and contains both Client's and Contractor's risks specific to the project. These risks are additional to the risks stated in clause 80.1 and 81.1 in the NEC3 ECC. Risks which are not carried by the Client are carried by the Contractor.

15. Is this risk allocation between the Client and the Contractor in the contract clear?

16. How did they determine the ownership of the risk? Did they allocate risk as much as possible to the other party or did they allocate risk to the party best able to manage it?

Option C of the Engineering and Construction Contract is often chosen, which means that the Client and the Contractor share the financial risk.
17. Why should anyone choose to apply Option C instead of the other Main Options?

The Clients risk register identifies risks, ownership of those risks and actions and will be maintained by the Project Manager. Risk reduction meeting are held to identify opportunities, to monitor risk mitigation actions, to plan for future risks, to record actions and to update the register. The risk register was not yet included in the NEC2, but it is included in the NEC3 (clause 16.1).

18. Do the Client, the Project Manager and the Contractor comply with these RM plans up to now? (Do these work well or are there any problems? Are the clauses in the NEC3 ECC clear?)

Appendix B1 - Meeting expert 1 – 29/10/2015

Name expert: Anja Beaujean- Kuijsters

Company/ function: Brink Groep, senior consultant

Connection NEC3 project ICC: Anja monitored and managed the tender of ICC

Introduction
1. Were you involved in the procurement of a NEC3 project? Yes, proceed with question 3, No, proceed with question 2.
      Yes
2. Do you have knowledge of the NEC3 contract but no experience with a NEC3 project? Yes, proceed with question 6.

Questions regarding trust during procurement

The first questions concern the procurement of the contract.
An important aspect to search for the best contractor is to find out if the tenderers have the following competences:
Capability to contribute towards collaborative working, relevant experience and a forward thinking culture, project management ability, target cost contracts and pain / gain mechanism.

3. Were the tender stages of the project sufficient to determine the Contractor and the other tenderers' trustworthiness (ability, integrity, predictability and reliability) to carry out the project?
      The main goal of the target contract is best value for money. Trust is developed during the procurement because of the open discussions, the curiosity of the tenderers, dialogues etc. And because the novelty of the collaboration the procedures were more extensive.

   ➔   Additional question; did the client also do research by looking into the trustworthiness of the contractor's representatives?
        An important difference between the British and Dutch construction Industry is that the Clients are in most cases investors who hire people to execute the works, while contractors in the Netherlands (such as an Heijmans) has his own construction workers. In NEC3 the client has a say in the selection of the subcontractors. This enhances the controllability of the process.

Clause 10.1 states that the Client, the Contractor, the Project Manager and the Supervisor shall act in a spirit of mutual trust and co-operation.
4. Did this clause have an influence on the behavior of the Client, the Project Manager and the Contractor?
      Trust is gained in the procurement stage. Co-operation is accomplished because of the open book system. Hiding the problems is not possible. When there is no trust in the beginning, such a contract will not work in its best way.

5. Do you think that this clause will always work in the Netherlands?
      When the procedures are followed, there is definitely a chance that the clause will work. But because this was the pilot in the Netherlands it is hard to say.

The Contract Documentation is subject to the Scots law and is a mixed legal system containing civil law and common law elements and includes the principle of good faith.

Questions regarding objectives (if no involvement in NEC3 projects, proceed with question 9)

This question deals with the project objectives. Project objectives are aligned with regard to the project results, the procedures and the relationship.
7. Do the joint project objectives with regard to the relationship have an influence on the behavior of the Client, the Project Manager and the Contractor?
      Mutual goals are set, taken into account the interests of every party. This enhances the relationship. Also setting up the target of the project enhances the relationship between the involved parties.

8. Do the Client, the Project Manager and the Contractor comply with these project objectives up to now?
      Yes, everything is going very well.

Option M (X15) is an option to include in the contract which limits the contractor's liability for his design to reasonable skill and care. In other words, the design does not have to be on the basis of fitness for purpose.

9. Why should a project manager or client choose to include this Option?

Reasonable skill and care is equal to 'efforts obligation'. This is the case with the DNR ('De Nieuwe Regeling'). Fitness for purpose is a 'performance obligation' within the UAV-GC. The ICC had a clear vision of the purpose and the design of the building. The choice was made not to include the option, because the design had to be fitness for purpose. The reason I can think of to include the option is when the client does not have a clear vision of the design and gives all control to the architect. The option could trigger trust.

Questions regarding communication (if no involvement in NEC3 project, proceed with question 15)

Communication is also covered in NEC3 ECC in clause 13. Communication must be in a form which can be read, copied and recorded, writing must be in English, the period of reply is two weeks, and a notification must be communicated separately. In addition, this clause sets out rules for replying to communication and the issuing of certificates.

10. Do the involved parties comply with this clause? (Does it work well or are there any problems?

Broadly speaking yes. The reply deadline is always met, but communication will always be done by means of verbal expression.

Besides formal communication, informal communication is also very important in projects.

11. Do you think that the client, the project manager and the contractor also have informal contact with each other?

There will always be informal contact between the involved parties. Informal contact is also a factor that enhances the trust between the parties.

Questions regarding problem solving

Clauses 60-65 in the NEC3 ECC deal with Compensation Events. The Project Manager plays an important role in the CE procedure. The occurrence of disputes may be referred to the Adjudicator.

12. Do the Client, the Project Manager and the Contractor comply with these clauses up to now? (Do they work well or are there any problems?) (Impartiality project manager, a lot of compensation events)

The operation of the compensation events was well explained in the meetings in the early stage of the procurement. During the project the involved parties complied with these clauses

13. What do the parties do during the project in order to solve problems by amiable agreement? (16.1 Early warning/10.1 Collaboration/Mutual help?)

There is an obligation to identify certain risks in an early stage called the early warning by the contractor, the project manager and the supervisor. The risk register is maintained and sharpened during the project and risks are allocated to the party best able to control the risks.

14. Do the Compensation Events have an influence on the trust level between the Client and the Contractor?

In certain ways yes. There is an obligation for both parties to notify a compensation event within a certain period of time. Compensation events refer to the Dutch word 'meerwerk'.

Questions regarding risks if no involvement in NEC3 project, just answer question 15)

This question covers the risk allocation. A workshop was held to identify and to evaluate contract risks, to allocate risk responsibility and ownership, and to quantify defined and overall risk costs. According to clause Z11, the Client risk register is developed jointly between the Client and the Contractor and contains both Client's and Contractor's risks specific to the project. These risks are additional to the risks stated in clause 80.1 and 81.1 in the NEC3 ECC. Risks which are not carried by the Client are carried by the Contractor.

15. Is this risk allocation between the Client and the Contractor in the contract clear?

Early meetings are planned with all parties to discuss the potential risks of the project. Early discussions are present to openly talk about the risks. There is an obligation to discuss and to jointly solve the risks periodically. In the contract the allocation of the risks have to be written very clear.

16. How did they determine the ownership of the risk? Did they allocate risk as much as possible to the other party or did they allocate risk to the party best able to manage it?

NEC3 is known for its common risk allocation. The client's risks are defined and the compensation events (when they are notified) are for the account of the Client.

Option C of the Engineering and Construction Contract is often chosen, which means that the Client and the Contractor share the financial risk.

17. Why did ICC choose to apply Option C instead of the other Main Options?

Best Value for Money. Financial incentive for collaboration, pain/gain mechanism. Common interest to control the costs. Also the preconditions for the tasks are very complex. The cost price could not be predetermined accurate.

The Clients risk register identifies risks, ownership of those risks and actions and will be maintained by the Project Manager. Risk reduction meeting are held to identify opportunities, to monitor risk mitigation actions, to plan for future risks, to record actions and to update the register. The risk register was not yet included in the NEC2, but it is included in the NEC3 (clause 16.1).

18. Do the Client, the Project Manager and the Contractor comply with these RM plans up to now? (Do these work well or are there any problems? Are the clauses in the NEC3 ECC clear?)

Yes, already explained in a previous question.

Appendix B2 - Meeting expert 2 – 03/11/2015

Name expert: Lenny de Kleijnen

Company/ function: TBI, lawyer

Connection NEC3 project: At the time of the ICC tender Lenny worked within the company Croon. Croon was one of the tenderers that ultimately did not execute the project.

Introduction

1. Were you involved in the procurement of a NEC3 project? Yes, proceed with question 3, No, proceed with question 2.
    Yes
2. Do you have knowledge of the NEC3 contract but no experience with a NEC3 project? Yes, proceed with question 6.

Questions regarding trust during procurement

The first questions concern the procurement of the contract.
An important aspect to search for the best contractor is to find out if the tenderers have the following competences: Capability to contribute towards collaborative working, relevant experience and a forward thinking culture, project management ability, target cost contracts and pain / gain mechanism.

3. Were the tender stages of the project sufficient to show your trustworthiness (ability, integrity, predictability and reliability) to carry out the project?

Yes. At first all tenderers were assessed by means of their track record. On the basis of this assessment, every suitable candidate was asked to come to a general presentation of the building project and an introduction in the New Engineering contract. The tender stages were very extensive; meetings with all parties, one to one interviews, dialogues with all parties and individual. During this period you got the feeling that you was given sufficient time to profile yourself.

On the other hand; because the contract and collaboration is very different from the Dutch way, it took a lot of effort to dive into the contract (financially and timely). A second questionable aspect is the knowledge a contractor should have of finance. The only collaboration in the Netherlands that asks for this knowledge is the DBFMO contract PPP (Public Private Partnership) where the F of Finance is a stumbling block.

Clause 10.1 states that the Client, the Contractor, the Project Manager and the Supervisor shall act in a spirit of mutual trust and co-operation.
4. Did this clause have an influence on the behavior of the Client, the Project Manager and the Contractor?

Trust was developed during the dialogues, but not during the selection of the tenderers.

5. Do you think that this clause will work in the Netherlands?

Yes. Because the contract works with an 'open book' system, the parties are aware of the fact that everything is executed according to a mutual interest.

The Contract Documentation is subject to the Scots law and is a mixed legal system containing civil law and common law elements and includes the principle of good faith.

6. Does this principle of good faith in Scots law have an influence on the behavior of the Client, the Project Manager and the Contractor in the Dutch construction industry in your opinion?

In some ways yes. Dutch companies work according to the principle of 'reasonableness and fairness'. Good faith is already created in the procurement stage, so it would not be logical if 'good faith' is not present during the execution of the works.

7. Do the joint project objectives with regard to the relationship have an influence on the behavior of the Client, the Project Manager and the Contractor?

Yes. The main goal of the Target Contract is to a high added value at the lowest possible price (pain/gain mechanism). Every stakeholder will benefit from this.

Questions regarding objectives (if no involvement in a NEC3 project, proceed with question 9)

This question deals with the project objectives. Project objectives are aligned with regard to the project results, the procedures and the relationship.
8. Do the Client, the Project Manager and the Contractor comply with these project objectives up to now?

Option M (X15) is an option to include in the contract which limits the contractor's liability for his design to reasonable skill and care. In other words, the design does not have to be on the basis of fitness for purpose.
9. Why should a project manager or client choose to include this Option?
When a client does not have a strict vision on the design of the project. When the client hires his own architects it could be possible that the architect is free to design the functional vision of the client. When this is the case, the client could include the clause of X15 to show the architect that he has full confidence in the capability of the designer.

Questions regarding communication (if no involvement in NEC3 project, just answer question 10)

Communication is also covered in NEC3 ECC in clause 13. Communication must be in a form which can be read, copied and recorded, writing must be in English, the period of reply is two weeks, and a notification must be communicated separately. In addition, this clause sets out rules for replying to communication and the issuing of certificates.

10. How will this work in the Dutch construction industry?
The English people work according to the Anglo-Saxon principle and the Dutch according to the reasonable & fairness. Dutch contractors are not used to provide every alteration on paper. The planning is the most important and every important change in the execution that is necessary to realize the planning is mostly accepted. Contract Management is less well known.

➔ Additional question: How transparent are the communication systems?
A great advantage of the NEC3 is that the connection of the systems of every stakeholder is formulated more objectively. Nowadays every party in a project team uses his own management system and quality system and in some cases a project manager could use a project management system that limits the contractor in his work. In NEC3 this is formulated objective what results in a better consensus.

11. Do the involved parties comply with this clause? (Does it work well or are there any problems?

Besides formal communication, informal communication is also very important in projects.
12. Do you think that the client, the project manager and the contractor also have informal contact with each other?

Questions regarding problem solving

Clauses 60-65 **in the NEC3 ECC deal with Compensation Events. The Project Manager plays an important role in the CE procedure.** The occurrence of disputes may be referred to the Adjudicator.

13. Do the Client, the Project Manager and the Contractor comply with these clauses up to now? (Do they work well or are there any problems?) (Impartiality project manager, a lot of compensation events)

14. What do the parties do during the project in order to solve problems by amiable agreement? (16.1 Early warning/10.1 Collaboration/Mutual help?)

15. Do the Compensation Events have an influence on the trust level between the Client and the Contractor?

Questions regarding risks if no involvement in NEC3 project, just answer question 15)

This question covers the risk allocation. A workshop was held to identify and to evaluate contract risks, to allocate risk responsibility and ownership, and to quantify defined and overall risk costs. According to clause Z11, the Client risk register is developed jointly between the Client and the Contractor and contains both Client's and Contractor's risks specific to the project. These risks are additional to the risks stated in clause 80.1 and 81.1 in the NEC3 ECC. Risks which are not carried by the Client are carried by the Contractor.

16. Is this risk allocation between the Client and the Contractor in the contract clear?

A remarkable difference between NEC3 and for example the UAV is that the traditional way of working describes the risk of the contractor and when a risk is not included in the contract, the risk is at the expense of the client/ project manager. In NEC3 this is reversed. The contractor describes the specific risks of the client and places all other risks on the contractor (except for the compensation events that have been notified within 8 weeks). The Dutch contractor industry is reticent because of this change.

17. How did they determine the ownership of the risk? Did they allocate risk as much as possible to the other party or did they allocate risk to the party best able to manage it?

Option C of the Engineering and Construction Contract is often chosen, which means that the Client and the Contractor share the financial risk.
18. Why should anyone choose option C instead of the other Main Options?

The Clients risk register identifies risks, ownership of those risks and actions and will be maintained by the Project Manager. Risk reduction meeting are held to identify opportunities, to monitor risk mitigation actions, to plan for future risks, to record actions and to update the register. The risk register was not yet included in the NEC2, but it is included in the NEC3 (clause 16.1).

19. Do the Client, the Project Manager and the Contractor comply with these RM plans up to now? (Do these work well or are there any problems? Are the clauses in the NEC3 ECC clear?)

Appendix B3 - Meeting expert 3 – 12/11/2015

Name expert: Erik Veldhuizen

Company/ function: Arcadis, project manager

Connection NEC3 project: Did research into the NEC3 contract

Introduction

1. Were you involved in the procurement of a NEC3 project? Yes, proceed with question 3, No, proceed with question 2.
    No
2. Do you have knowledge of the NEC3 contract but no experience with a NEC3 project? Yes, proceed with question 5.
    Yes

Questions regarding trust

The first questions concern the procurement of the contract.
An important aspect to search for the best contractor is to find out if the tenderers have the following competences:
Capability to contribute towards collaborative working (including in the Design), Relevant experience and a forward
thinking culture, Project management ability and familiarity with partnering, target cost contracts and pain / gain share .

3. Were the tender stages of the project sufficient to determine the Contractor and the other tenderers' trustworthiness
(ability, integrity, predictability and reliability) to carry out the project?

Clause 10.1 states that the Client, the Contractor, the Project Manager and the Supervisor shall act in a spirit of mutual
trust and co-operation.
4. Did this clause have an influence on the behavior of the Client, the Project Manager and the Contractor?

5. Do you think that this clause will work in the Netherlands?
    Yes, however this clause remains intangible. In the Dutch construction industry, the trust aspect is higher in the
regional development, were procurement is mostly based on relations. The construction of a building is more
functional/target-specific where the procurement is built upon expertise.

The Contract Documentation is subject to the Scots law and is a mixed legal system containing civil law and common law
elements and includes the principle of good faith.

6. Does this principle of good faith in Scots law have an influence on the behavior of the Client, the Project Manager and
the Contractor in the Dutch construction industry in your opinion?
    When there is no good faith, a project should not have started in the first place. Even if the Dutch construction
industry is conservative, good faith is already enhanced in the procurement stage.

7. Do the joint project objectives with regard to the relationship have an influence on the behavior of the Client, the
Project Manager and the Contractor?
    Yes definitely. Especially when the target contract is applied. Everything is discussed on forehand and the client
is much more concerned with the process of the project. A difference between the traditional way of working is that the
Client also determines the subcontractors of the contractor.

Questions regarding objectives (if no involvement in NEC3 project, proceed with question 9)

This question deals with the project objectives. Project objectives are aligned with regard to the project results, the
procedures and the relationship.
8. Do the Client, the Project Manager and the Contractor comply with these project objectives up to now?

Option M (X15) is an option to include in the contract which limits the contractor's liability for his design to reasonable
skill and care. In other words, the design does not have to be on the basis of fitness for purpose.
9. Why should a project manager or client choose to include this Option?
    I don't know why a client would include this option. Has this already happened in a project?
The only reason I can think of is to create trust when this clause is included.

Questions regarding communication (if no involvement in NEC3 project, proceed with question 15)

Communication is also covered in NEC3 ECC in clause 13. Communication must be in a form which can be read, copied and recorded, writing must be in English, the period of reply is two weeks, and a notification must be communicated separately. In addition, this clause sets out rules for replying to communication and the issuing of certificates.

10. Do the involved parties comply with this clause? (Does it work well or are there any problems?

Besides formal communication, informal communication is also very important in projects.
11. Do you think that the client, the project manager and the contractor also have informal contact with each other?

Questions regarding problem solving

Clauses 60-65 in the NEC3 ECC deal with Compensation Events. The Project Manager plays an important role in the CE procedure. The occurrence of disputes may be referred to the Adjudicator.
12. Do the Client, the Project Manager and the Contractor comply with these clauses up to now? (Do they work well or are there any problems?) (Impartiality project manager, a lot of compensation events)

13. What do the parties do during the project in order to solve problems by amiable agreement? (16.1 Early warning/10.1 Collaboration/Mutual help?)

14. Do the Compensation Events have an influence on the trust level between the Client and the Contractor?

Questions regarding risks if no involvement in NEC3 project, just answer question 15)

This question covers the risk allocation. A workshop was held to identify and to evaluate contract risks, to allocate risk responsibility and ownership, and to quantify defined and overall risk costs. According to clause Z11, the Client risk register is developed jointly between the Client and the Contractor and contains both Client's and Contractor's risks specific to the project. These risks are additional to the risks stated in clause 80.1 and 81.1 in the NEC3 ECC. Risks which are not carried by the Client are carried by the Contractor.

15. Is this risk allocation between the Client and the Contractor in the contract clear?
        I have interpreted the clause as follows: the risk register is developed jointly in the beginning of the project, taken into account the capabilities of the parties to allocate the risks in a proper way. Compensation events are events for which the Client carries the risks.

➔   Additional question 16: How do they handle the risks in your opinion?
Many contractors feel that making note of a risk that could occur is a degree of incompetence. But it should be interpret as a high quality control measure and knowledge of the project.

16. How did they determine the ownership of the risk? Did they allocate risk as much as possible to the other party or did they allocate risk to the party best able to manage it?

Option C of the Engineering and Construction Contract is often chosen, which means that the Client and the Contractor share the financial risk.
17. Why should anyone choose Option C instead of the other Main Options?

The Clients risk register identifies risks, ownership of those risks and actions and will be maintained by the Project Manager. Risk reduction meeting are held to identify opportunities, to monitor risk mitigation actions, to plan for future risks, to record actions and to update the register. The risk register was not yet included in the NEC2, but it is included in the NEC3 (clause 16.1).

18. Do the Client, the Project Manager and the Contractor comply with these RM plans up to now? (Do these work well or are there any problems? Are the clauses in the NEC3 ECC clear?)

Appendix C - Email send to experts of HEVO with or without knowledge of NEC3

Beste collega's,

Ik zit al weer meer dan twee maanden bij HEVO te werken aan mijn afstudeerscriptie, met als begeleiders Willem en Lara. Ik zie jullie wel eens denken: 'Wat doet die meid hier eigenlijk?'

Zijn jullie een beetje op de hoogte van de verbouwing van het Internationaal Gerechtshof in Den Haag? Dit project wordt gemanaged volgens het Engelse contract NEC3, wat door velen wordt gezien als de vervanger van de UAV-GC 2005. Brink Groep heeft hier al mee gewerkt en is zeer positief over de verdere implementatie in de Nederlandse bouwwereld. Echter is het lastig om zo'n dergelijk contract van de grond te krijgen in Nederland door andere denkwijzen in Engeland op het gebied van contractdocumenten (alles staat vastgelegd), redelijkheid en billijkheid, vertrouwen tussen stakeholders, sterke betrokkenheid opdrachtgever (veel controles) etc. Ik onderzoek voor HEVO de voor- en nadelen van het contract en probeer relevante clausules die beduidend anders zijn dan de Nederlandse manier van samenwerken in kaart te brengen.

Voor mijn onderzoek heb ik een korte vragenlijst opgesteld, ik zou het op prijs stellen als jullie hem voor mij willen invullen.

Sommige aspecten in de vragen lijken in eerste instantie vanzelfsprekend in een bouwsamenwerking. Het is belangrijk dat onderdelen van dezelfde vraag ook worden beoordeeld in relatie tot elkaar. Belangrijk om te vermelden is dat er géén voorkennis van het contract nodig is en dat de vragen in het Engels zijn. Het uiteindelijke doel is het vinden van de belangrijkste factoren aangegeven door experts in de Nederlandse bouwsector.

De vragenlijst bevat 12/13 vragen (afhankelijk van een gegeven antwoord) en duurt ongeveer 5-7 minuten.

Ik verloot op het einde 5 cadeaubonnen van bol.com ter waarde van 20 euro tussen de respondenten (circa 100) als blijk van waardering.

Hieronder vindt u de link naar de survey:

www.thesistools.com/collaboration-in-the-Dutch-building-industry

Graag ontvang ik jullie antwoorden op de vragen voor 8 december a.s.

Met vriendelijke groet,

Lizet Geertsma

Afstudeerster Master Construction Management & Engineering TU/e

Appendix C1 - Email send to experts with or without knowledge of NEC3 outside of HEVO

Geachte lezer,

Momenteel ben ik volop bezig met mijn afstudeerscriptie bij HEVO B.V., met als onderwerpen contractmanagement, samenwerkingsvormen & risicomanagement. Voordat ik uitleg wat het doel van de survey is, een kleine introductie:

Bent u een beetje op de hoogte van de verbouwing van het Internationaal Gerechtshof in Den Haag? Dit project wordt gemanaged volgens het Engelse contract NEC3, wat door velen wordt gezien als de vervanger van de UAV-GC 2005. Een aantal Nederlandse bouw gerelateerde bedrijven hebben hier al mee gewerkt (vooral in buitenland en één in Nederland) en zijn zeer positief over de verdere implementatie in de Nederlandse bouwwereld. Echter is het lastig om zo'n dergelijk contract van de grond te krijgen in Nederland door andere denkwijzen in Engeland op het gebied van contractdocumenten (alles staat vastgelegd), redelijkheid en billijkheid, vertrouwen tussen stakeholders, sterke betrokkenheid opdrachtgever (veel controles) etc. Ik onderzoek de voor- en nadelen van het contract en probeer relevante clausules die beduidend anders zijn dan de Nederlandse manier van samenwerken in kaart te brengen.

Voor mijn onderzoek heb ik een korte vragenlijst opgesteld, ik zou het op prijs stellen als u hem voor mij wilt invullen. Sommige aspecten in de vragen lijken in eerste instantie vanzelfsprekend in een bouwsamenwerking. Het is belangrijk dat onderdelen van dezelfde vraag ook worden beoordeeld in relatie tot elkaar. Belangrijk om te vermelden is dat er géén voorkennis van het contract nodig is en dat de vragen in het Engels zijn. Het uiteindelijke doel is het vinden van de belangrijkste factoren aangegeven door experts in de Nederlandse bouwsector.

De vragenlijst bevat 12/13 vragen (afhankelijk van een gegeven antwoord) en duurt ongeveer 5-7 minuten.

Ik verloot op het einde 5 cadeaubonnen van bol.com ter waarde van 20 euro tussen de respondenten (circa 100) als blijk van waardering.

Hieronder vindt u de link naar de survey:

www.thesistools.com/collaboration-in-the-Dutch-building-industry

Graag ontvang ik uw antwoorden op de vragen voor 8 december a.s.

Alvast bedankt voor uw medewerking! De resultaten zullen gebundeld worden in een uittreksel dat beschikbaar is voor degenen die hun emailadres opgeven in de survey.

Met vriendelijke groet,

Lizet Geertsma

Afstudeerster Master Construction Management & Engineering TU/e

Appendix D - Questionnaire for experts with or without knowledge of NEC3

Collaboration in the Dutch construction industry

Dear participant,

For my graduation thesis I am investigating the new contract NEC3 and the possible implementation in the Dutch construction Industry. For this questionnaire you don't need specific knowledge of the contract, experience and knowledge of Dutch construction/building projects is much more important. It is of high importance that the attributes are assessed carefully and in relation to each other, because the goal is to find the attributes that matters the most. It only takes 5-8 minutes to fill in the whole questionnaire.

Thank you in advance!

[Start]

1. What is your field of work? *

☐ Project manager

☐ Contractor

☐ Consultant

☐ Architect

☐ Other [   ]

2. How many years of experience do you have in the construction industry? *

☐ <5

☐ 6-10

☐ 11-15

☐ 16-20

☐ >20

3. Number of completed projects the last 5 years *

☐ <2

☐ 2-5

☐ 6-10

☐ >10

4. How many of those projects were managed according to the UAV-gc?

☐ <2

☐ 2-5

☐ 6-10

☐ >10

5. Have you ever heard of the British NEC3 contract? *

☐ Yes

☐ No

6. Do you have any experience with the NEC3 contract? *

☐ Yes

☐ No

7. Please mark the bullet that best reflects the degree of importance of the following attributes in developing trust between all stakeholders in a building project (considering the successfulness of a temporary project).

	Low importance				High importance
a. Clearness defined job tasks	☐	☐	☐	☐	☐
b. Clearness defined contract documents	☐	☐	☐	☐	☐
c. The contractor has high qualification level	☐	☐	☐	☐	☐
d. Attending work-related interaction	☐	☐	☐	☐	☐
e. Available information of other parties to judge competences	☐	☐	☐	☐	☐
f. Good interaction to obtain information from other party	☐	☐	☐	☐	☐
g. Personal relationship improving working relationship	☐	☐	☐	☐	☐
h. Encouraging satisfactory outcome by taking each party's needs into account in decision making process	☐	☐	☐	☐	☐
i. Feeling that the contractor will not damage the interests of other parties	☐	☐	☐	☐	☐
j. Implementing a transparent communication system (for example a share point)	☐	☐	☐	☐	☐

8. How do the following attributes impact the performance of a building project, leading to project success?
(*Background information: the client's risks are detailed and places all other risks on the contractor)

	Low impact				High impact
Technical expertise	☐	☐	☐	☐	☐
Attitude defects liability	☐	☐	☐	☐	☐
Close collaboration	☐	☐	☐	☐	☐
Clearness of risk allocation policy*	☐	☐	☐	☐	☐

9. How do the following attributes impact the performance of a building project, leading to project success? (*Background information: parties work according to an open book system, where they are obliged to notify each other for delays, cost overruns etc within 8 weeks)

	Low impact				High impact
Early warning system*	☐	☐	☐	☐	☐
A very detailed work specification with all necessary information included in the contract	☐	☐	☐	☐	☐
Flexibility in critical path of planning	☐	☐	☐	☐	☐

10. How do the following attributes impact the performance of a building project, leading to project success? (*Background information: parties develop goals and a risk register jointly)

	Low impact				High impact
Tender quality (sufficient time to profile each tenderer)	☐	☐	☐	☐	☐
Detailing of safety record	☐	☐	☐	☐	☐
Quality control and quality risk programs*	☐	☐	☐	☐	☐
Joint goal setting (objectives)	☐	☐	☐	☐	☐

11. How do the following attributes impact the performance of a building project, leading to project success?

	Low impact				High impact
Controllability up to project delivery	☐	☐	☐	☐	☐
Cost savings	☐	☐	☐	☐	☐
On time delivery	☐	☐	☐	☐	☐
Good added value (quality)	☐	☐	☐	☐	☐

12. Considering the above mentioned attributes concerning the process, cost (savings and budget), time and quality, please indicate the importance of achieving the following project goals (*Background information: Risk reduction meetings are meetings where stakeholders make or consider proposals on how the effect of registered risks can be avoided)

	Low importance				High importance
Stakeholders make efficient decisions due to the problem solving procedure	☐	☐	☐	☐	☐
Proposals regarding cost savings lead to higher profit margins for both client and contractor	☐	☐	☐	☐	☐
The project meets the target date as stated in the contract	☐	☐	☐	☐	☐
Improvement of quality could be achieved by risk reduction meetings* and joint evaluation	☐	☐	☐	☐	☐
Problems are recognized in an early stage through these meetings	☐	☐	☐	☐	☐
Reduced claims, variations and risk of disputes	☐	☐	☐	☐	☐

| The project can meet the target budget | ☐ | ☐ | ☐ | ☐ | ☐ |

13. Would you like to have the opportunity to win (out of 100 respondents) one of the five Bol.com vouchers of 20 euros and a summary of my thesis on the contract of the future NEC3? Please enter your emailadres

[ ]

Submit the answ ers

Thank you for participating in my questionnaire! If you have any more questions, please contact me at lizet.geertsma@hevo.nl

Appendix E – Data screening ThesisTools Excel output

Table 1
34 blank questionnaires (excel)

ID	Worl	Expe	Proj	UAV	Kno	ST1	ST2	ST3	ST4	SBW	SBW	SBW	SBW	PC1	PC2	PC3	QP1	QP2	QP3	QP4	OSM	OSM	OSM	OSM	ID	0
1	5	2	1	1	2																				6	19
2	1	5	4	1	2																				7	19
3	1	5	2	1	2																				15	19
4	1	1	1	1	2																				17	19
5	1	5	4	2	2																				25	19
6	1	5	2	2	2																				40	19
7	1	5	3	1	2																				42	19
8	3	3	1	1	2																				45	19
9	5	4	1	1	2																				51	19
10	1	1	1	1	2																				55	19
11	1	1	1	1	2																				60	19
12	1	4	4	1	2																				63	19
13	1	5	2	1	2																				73	19
14	5	1	2	2	2																				75	19
15	5	5	1	2	2																				85	19
16	5	2	4	2	2																				88	19
17	1	2	2	1	2																				93	19
18	3	1	2	2	2																				94	19
19	1	3	2	2	2																				101	19
20	1	5	3	2	2																				105	19
21	5	5	4	1	2																				110	19
22	3	2	3	2	2																				117	19
23	3	4	2	1	1																				21	19
24	1	1	1	1	1																				23	19
25	1	3	3	1	1																				62	19
26	2	2	2	1	1																				77	19
27	5	4	3	2	1																				81	19
28	3	3	4	2	1																				82	19
29	1	3	2	2	1																				102	19
30	1	3	2	2	1																				103	19
31	1	3	2	1	1																				107	19
32	2	4	2	2	1																				108	19
33	2	4	2	1	1																				115	19
34	3	5	2	2	1																				118	19
35	2	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
36	3	3	4	2	2	4	4	4	5	5	3	3	2	3	5	2	4	4	4	5	3	3	3	4	4	0
37	1	3	2	1	2	5	4	4	5	4	4	5	5	4	3	4	4	4	4	5	5	4	4	5	8	0
38	1	5	2	1	2	5	5	4	4	4	4	3	4	3	3	4	4	2	4	4	3	4	4	4	9	0
39	3	5	4	1	2	5	5	5	5	5	5	4	5	5	4	4	4	4	5	4	4	4	5	5	10	0
40	1	2	3	1	2	4	4	4	5	4	5	3	4	5	3	4	2	2	3	4	5	4	3	5	13	0
41	3	1	1	1	2	5	5	5	5	5	4	4	4	4	4	4	4	4	5	5	4	4	5		14	0

Table 2
The standard deviation of the responses (last column)

ID	Worl	Expe	Proj	UAV	Kno	ST1	ST2	ST3	ST4	SBW	SBW	SBW	SBW	PC1	PC2	PC3	QP1	QP2	QP3	QP4	OSN	OSN	OSN	OSN	ID		0	stdev
36	2	5	2	1	2	4	4	4	4	4	5	4	4	5	4	3	4	4	4	4	4	4	4	4	48		0	0,394
37	3	1	1	1	1	5	5	5	5	5	5	4	5	5	4	5	5	4	5	5	5	4	5	5	132		0	0,408
38	2	5	4	4	1	5	4	4	4	4	4	4	4	4	4	4	4	5	5	4	4	5	5	4	104		0	0,465
39	2	4	2	2	2	5	5	5	5	5	4	4	5	5	4	5	4	5	5	4	4	4	5	5	76		0	0,482
40	3	5	4	1	2	5	5	5	5	5	5	4	5	5	4	4	4	4	5	4	4	4	5	5	10		0	0,494
41	3	1	1	1	2	5	5	5	5	5	4	4	4	4	4	4	4	4	4	5	5	4	4	5	14		0	0,494
42	1	5	4	4	2	4	4	4	5	5	5	4	4	5	4	5	4	4	4	5	5	4	5	5	131		0	0,494
43	3	5	3	2	1	5	5	4	5	4	5	5	5	5	4	5	4	4	5	4	5	4	4	5	92		0	0,494
44	1	5	4	2	2	4	4	4	4	4	4	3	3	4	5	4	3	3	4	4	4	3	4	4	30		0	0,521
45	1	2	2	2	1	4	4	3	4	4	4	4	4	2	3	4	4	4	4	4	4	4	4	4	27		0	0,521
46	3	4	2	2	1	5	5	4	4	4	4	3	4	4	4	4	5	4	5	4	4	4	4	4	29		0	0,521
47	3	5	4	4	1	4	4	4	3	4	3	4	4	4	4	3	4	4	4	4	3	3	3	5	96		0	0,547
48	1	3	2	1	2	5	4	4	5	4	4	5	5	4	3	4	4	4	4	5	5	4	4	5	8		0	0,567
49	3	4	2	2	2	4	4	3	5	4	4	5	5	4	4	5	3	4	4	5	4	4	4	4	114		0	0,586
50	1	2	3	3	1	5	4	4	5	4	4	3	4	3	4	4	4	5	5	4	4	4	5	5	95		0	0,586
51	1	5	2	1	2	5	5	4	5	5	4	5	4	5	3	5	4	4	4	5	4	4	4	5	52		0	0,591
52	1	2	1	1	2	5	5	4	3	5	4	4	5	4	4	5	4	4	5	5	4	4	5	5	116		0	0,591
53	1	5	2	2	1	5	4	4	5	5	4	4	5	5	4	3	4	5	5	4	4	5	5	5	97		0	0,591
54	2	3	4	4	2	4	4	5	5	5	5	3	5	4	5	5	5	4	5	4	4	4	4	4	39		0	0,595
55	4	2	2	2	2	4	4	5	5	5	5	3	5	4	5	5	5	4	5	4	4	4	4	5	128		0	0,595
56	1	3	3	3	2	5	5	5	5	5	4	4	5	3	5	4	5	5	4	5	4	4	5	5	129		0	0,595
57	3	5	4	1	1	3	4	3	2	4	4	3	4	4	4	4	3	3	4	4	3	3	3	4	19		0	0,595
59	1	2	3	2	2	4	5	3	5	5	4	3	5	4	4	5	4	4	4	4	4	4	4	5	84		0	0,614
60	1	4	2	2	1	5	4	4	3	4	5	4	4	5	4	4	4	3	5	4	4	5	4	5	11		0	0,614
61	3	3	2	1	1	4	4	4	5	4	4	4	5	4	3	4	3	4	5	4	4	5	5	5	22		0	0,614
64	1	5	4	4	1	5	5	5	5	5	3	5	3	5	5	5	5	5	5	5	5	5	4	5	86		0	0,636
65	5	2	4	4	2	5	5	4	3	4	3	4	4	3	3	4	5	4	3	4	4	4	4	4	35		0	0,640
66	3	2	2	1	2	5	5	4	5	5	4	3	5	5	4	4	4	4	5	5	5	4	3	4	122		0	0,666
67	3	4	3	4	1	5	5	4	3	5	5	4	3	5	4	4	4	5	4	5	5	4	5	4	41		0	0,666
68	5	4	4	4	1	3	3	4	4	4	3	3	5	4	3	4	4	3	4	5	3	3	3	4	72		0	0,666
70	5	1	1	1	2	4	4	3	4	4	5	3	4	5	3	4	4	3	3	4	3	4	5	4	24		0	0,670
71	4	3	4	3	2	5	5	5	5	5	4	3	5	4	5	5	4	4	5	5	4	4	3	5	78		0	0,678
72	1	1	1	1	2	5	5	5	5	5	4	4	5	5	3	5	4	4	5	5	5	3	4	5	127		0	0,678
74	3	2	4	2	1	5	4	5	5	5	4	3	5	5	5	4	4	4	5	5	5	4	3	5	38		0	0,678
75	3	4	2	1	1	4	4	3	5	4	5	4	4	3	3	4	4	4	5	5	4	3	4	5	20		0	0,686
76	3	5	2	1	1	5	4	4	4	5	4	4	5	5	4	3	4	3	5	4	4	3	4	3	80		0	0,686
77	1	5	2	1	2	5	5	4	4	4	3	4	3	3	4	2	4	3	4	4	4	4	4	5	9		0	0,694
78	1	3	2	1	2	4	4	4	5	4	5	3	5	5	3	4	3	4	4	5	5	4	4	5	50		0	0,694
79	2	3	2	1	2	3	4	3	3	4	5	4	4	5	3	3	4	4	3	5	4	3	4	4	74		0	0,694
80	3	4	4	2	1	5	5	4	4	5	5	3	4	5	4	5	3	4	4	5	4	3	4	5	37		0	0,694
81	4	3	2	1	2	4	3	4	4	3	3	2	3	4	3	4	4	3	3	3	4	2	2	4	99		0	0,714

Table 3
Frequencies missing data

		SBW1 Technical expertise	SBW2 Attitude defects liability	SBW3 Successful past projects	SBW4 Clearness of risk allocation policy*	PC1 Early warning system	PC2 A very detailed work specification with all necessary information included in the contract	PC3 Flexibility in critical path of planning
N	Valid	93	93	93	93	93	93	93
	Missing	1	1	1	1	1	1	1

Table 4
Replaced missing values

	Result Variable	N of Replaced Missing Values	Case Number of Non-Missing Values		N of Valid Cases	Creating Function
			First	Last		
1	SBW1	1	1	94	94	MEDIAN(SBW1,ALL)
2	SBW2	1	1	94	94	MEDIAN(SBW2,ALL)
3	SBW3	1	1	94	94	MEDIAN(SBW3,ALL)
4	SBW4	1	1	94	94	MEDIAN(SBW4,ALL)
5	PC1	1	1	94	94	MEDIAN(PC1,ALL)
6	PC2	1	1	94	94	MEDIAN(PC2,ALL)
7	PC3	1	1	94	94	MEDIAN(PC3,ALL)

Table 5
Kurtosis

		SBW1	NEC3knowledge	NEC3experience
N	Valid	94	94	94
	Missing	0	0	0
Kurtosis		2,602	-2,042	2,590

Appendix F – Multivariate assumptions

Table 6
Linear relationship between Overall success of project and the four 'independent' factors.

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,217	25,564	1	92	,000	1,085	,331		
Logarithmic	,218	25,639	1	92	,000	,665	1,265		
Inverse	,216	25,304	1	92	,000	3,603	-4,702		
Quadratic	,218	12,680	2	91	,000	,683	,542	-,027	
Cubic	,218	12,680	2	91	,000	,683	,542	-,027	,000
Compound	,217	25,466	1	92	,000	1,335	1,156		
Power	,218	25,660	1	92	,000	1,109	,554		
S	,217	25,440	1	92	,000	1,392	-2,065		
Growth	,217	25,466	1	92	,000	,289	,145		
Exponential	,217	25,466	1	92	,000	1,335	,145		
Logistic	,217	25,466	1	92	,000	,749	,865		

The independent variable is ST.

Dependent Variable: OSN

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,203	23,410	1	92	,000	1,363	,395		
Logarithmic	,206	23,845	1	92	,000	1,524	,919		
Inverse	,201	23,079	1	92	,000	3,176	-1,982		
Quadratic	,208	11,932	2	91	,000	,747	,924	-,110	
Cubic	,209	12,025	2	91	,000	,881	,706	,000	-,017
Compound	,201	23,169	1	92	,000	1,509	1,188		
Power	,204	23,578	1	92	,000	1,620	,401		
S	,199	22,825	1	92	,000	1,203	-,865		
Growth	,201	23,169	1	92	,000	,411	,172		
Exponential	,201	23,169	1	92	,000	1,509	,172		
Logistic	,201	23,169	1	92	,000	,663	,842		

The independent variable is SBW.

Dependent Variable: OSN

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,010	,894	1	92	,347	2,548	-,065		
Logarithmic	,011	1,004	1	92	,319	2,520	-,152		
Inverse	,013	1,198	1	92	,277	2,244	,334		
Quadratic	,010	,442	2	91	,644	2,562	-,077	,003	
Cubic	,063	2,012	3	90	,118	6,626	-5,922	2,658	-,384
Compound	,010	,962	1	92	,329	2,539	,971		
Power	,011	1,048	1	92	,309	2,505	-,068		
S	,013	1,201	1	92	,276	,796	,147		
Growth	,010	,962	1	92	,329	,932	-,030		
Exponential	,010	,962	1	92	,329	2,539	-,030		
Logistic	,010	,962	1	92	,329	,394	1,030		

The independent variable is PC.

Dependent Variable: OSN

Equation	Model Summary					Parameter Estimates			
	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	,113	11,755	1	92	,001	1,750	,144		
Logarithmic	,108	11,087	1	92	,001	1,598	,539		
Inverse	,091	9,241	1	92	,003	2,789	-1,687		
Quadratic	,113	5,818	2	91	,004	1,797	,120	,003	
Cubic	,115	3,883	3	90	,012	2,314	-,322	,120	-,010
Compound	,104	10,660	1	92	,002	1,806	1,062		
Power	,099	10,077	1	92	,002	1,694	,226		
S	,084	8,414	1	92	,005	1,027	-,708		
Growth	,104	10,660	1	92	,002	,591	,060		
Exponential	,104	10,660	1	92	,002	1,806	,060		
Logistic	,104	10,660	1	92	,002	,554	,941		

The independent variable is QP.

Table 7
Variance Inflation Factor (VIF) for analyzing co linearity between 'independent' factors

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,806	,375		4,818	,000		
	SBW	,263	,111	,212	2,356	,021	,966	1,035
	QP	,211	,056	,350	3,772	,000	,910	1,099
	PC	,218	,086	,232	2,541	,013	,940	1,063

a. Dependent Variable: ST

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,687	,342		4,927	,000		
	QP	,038	,055	,078	,692	,491	,790	1,266
	PC	-,052	,081	-,068	-,637	,526	,881	1,135
	ST	,221	,094	,273	2,356	,021	,751	1,332

a. Dependent Variable: SBW

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,023	,488		2,097	,039		
	ST	,308	,121	,288	2,541	,013	,758	1,320
	SBW	-,087	,136	-,066	-,637	,526	,914	1,094
	QP	,082	,071	,128	1,154	,252	,798	1,254

a. Dependent Variable: PC

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1,128	,725		1,557	,123		
	PC	,177	,154	,114	1,154	,252	,890	1,123
	ST	,646	,171	,390	3,772	,000	,819	1,221
	SBW	,138	,200	,068	,692	,491	,915	1,093

a. Dependent Variable: QP