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Karel Doorman: from project to product

An explorative case study

MSc. thesis Rayke Maria Derksen

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Royal HaskoningDHV
Enhancing Society Together

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Karel Doorman: from project to product

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Author
R.M. Derksen (Rayke) – s0190810

Educational institution
University of Twente – Enschede, The Netherlands
Faculty Behavioural, Management and Social Sciences (BMS)
Master Industrial Engineering and Management – Production and Logistics Management

Company
Royal HaskoningDHV
Business Line Buildings
Business Unit New strategic Initiatives

Supervisory committee
Internal supervisors
Dr. P.C. Schuur
Dr. J.T. Voordijk
External supervisor
Ir. B. Brink MBA

Contact details
University of Twente
Faculty Behavioural, Management and Social Sciences
Department IEBIS
✉P.O. Box 217
7500 AE Enschede
The Netherlands
☎053 489 91 11

Royal HaskoningDHV
BL Buildings/BU NSI
✉P.O. Box 1132
3800 BC Amersfoort
☎088 348 20 00

PREFACE

This report marks the end of seven years being a student at the University of Twente. Let me start with putting some emphasis on the phrase 'being a student'. I could have written 'of studying' as well, but that would not do justice to what student life has contributed to my personal development. Being a student means so much more than attending lectures and taking exams. It was being a student with all the extracurricular activities that brought me to this point, the point at which I can confidently say: 'I am ready for the next level in life.'

Of course being a student does include all those courses, lectures, assignments, and exams as well. All that knowledge enables me to act on professional level. Besides the interesting courses from my master programme Industrial Engineering & Management - Production- and Logistic management track, I fully grabbed the opportunities to explore the boarders of my discipline by taking several courses from other master programmes. I am very pleased by the opportunities that University of Twente and my master programme offered me in doing so.

This leads me to the core subject of this preface, my master assignment that has led to this thesis. During this master assignment I had the opportunity to explore the bounderies of my discipline as well. The past seven months were extremely valuable. I have learned a lot about the construction industry and its consulting- and engineering services. The word 'bestek' has a whole different meaning to me now. On the other hand, I hope that I have learned my collegues at Royal HaskoningDHV a lot about supply chain management, supplier management, risk assessment, and business models.

Completing this thesis, however, was a bumby road. The Dutch expression: 'het venijn zit in de staart' (the sting is in the tail) does not apply to my bumpy road, I would rather say: 'Alle begin is lastig'. Completing my research plan took a lot of time and rewriting. For that, I have to blame my internal supervisors. And with blame I of course mean thank. Peter en Hans, I enjoyed our discussions on-topic, as well as off-topic, very much. You guided me through the struggles I had with defining my research in a scientific way, and besides of the on topic discussions our meetings were just very entertaining. I remember Hans, literaly standing on Peter's desk, pointing at a map of Rotterdam. Thank you both for your guidance and support.

Although I never have cought my external supervisor,nor my otherNSI collegues standing on their desks, I had a very good time at Royal HaskoningDHV as well. The NSI meetings were very valuable, both for understanding the construction industry as for conducting my research. Bart H., Hermen Jan, John, Bas, and Deena, thank you for your support. You were a valuable source of information and above all very supportive collegues.

A special 'thank you' to my external supervisor and NSI collegue, Bart Brink. You were very enthousitiastic, resourceful, and supportive, but what I liked the most was the trust in me

that you showed. You gave me a lot responsibilities regarding managing my own research project, but also in fully participating in NSI activities. For the latter, a special thanks should be adressed to John and Bart H. as well.

Besides these collegues, who I met several times per month, there were collegues from the Business Line that I saw on a regular basis at the Amersfoort office. You were very welcoming and always showed interest in my research progress, as well as my weekends. Providing a list of names here would be tricky business, since I would feel very guilty if I would forget somebody. Nevertheless, a big thank you to you all, especially the ones that could be find on a regular basis at the beautiful 'flex island' surrounded at column 19.

There is someone, although not located in Amersfoort, that should be named and thanked here for all her support. Sophie, there is no one that showed more interest and care than you did, although it was not always face-to-face, it was still very valuable to me.

And of course, thank you, Rowan, for our relaxing coffee breaks. I really enjoyed those, as well as I enjoyed organizing and hosting our hugely succesfull Intern drink. 'Interns Drinking Together'!

Now that I have thanked all the people that were heavenly involved in my master assignment, there are people to thank that were very supportive and important in the background as well; Not only during my master assignment, but also in the seven years of being a student.

Let's start with my beloved hockeyteam, Drienerlo Dames 1, you were an awsome source of distraction, but above that a lovely bunch of friends that contributed a lot to my personal development as well. A special thanks to Marije, Joannet, and Marit (I miss you, Miss USA). Without you I would have definitely consumed less alcohol, but I also would not enjoyed student life in Twente as much as I did now. You were always there for me, for having fun, but also being a listening ear. Thank you so much for that!

And then to all my fellow board members from Drienerlo, as well as the Bedrijvendagen, committee members, (study) friends, and roommates: we had so much fun, we organized awsome things, we learned a lot from eachother, we laughed, we ate, we drank, we shared our concerns; together. Together, to me, is the very valuable keyword in here. Thank you all!

When moving out as a 17 year-old, it was furthermore extremely comforting to know that you can allways rely on family. Visiting family and especially my grandparents (in the beginning I was so lucky to have all four of you there) on a more regular basis than ever, was a true benefit of living in Enschede. But also the familiy that I had to leave back in Groningen was a true support. Dear Thom, Papa en Mama, I feel blessed with the confidence that you showed in me. My somewhat drastic plans concerning the organization of my student life (like my decision in my first week as a student to attent the Drienerlo board) would not have

become a success without your endless support. And let those things be the things from which I learned the most. Thom, I really hope that you feel that same support. You are a student now as well, and I just wish that you make the most of it, just like I did.

Dear Daan, you were there just from the very beginning of my life as a student, first as a valuable friend, a year later as the most supportive, sage, and caring boyfriend that I could wish for. Thank you for your encouragement at the moments that I needed it the most. Thank you for the lovely things we have done together. Thank you for just being you and being there. To very nice continuation of all of that in the next phase of our lives!

Dear reader, I may have to appologize for this extraordinairy long preface. However, none of the words could have been left unspoken. Let me warn you beforehand: you may recognize in the remainder of this report that I am not that short-spoken in general. Nevertheless, I thank you very much for showing interest in my work, and I hope you enjoy reading it afterall.

- Rayke Derksen, Amersfoort, August 2015

MANAGEMENT SUMMARY

This report is the end result of our research which was performed to complete the author's master study Industrial Engineering and Management at the University of Twente. We conducted our research at Royal HaskoningDHV, business line Buildings, business unit NSI. The research is about changing projects into products.

The business unit NSI is founded to turn project into replicable products. We summarized the underlying logic in 2 drivers and 2 enablers. The drivers are changed customer demands and the need for higher profitability. Enablers for turning projects into products are the developments in projects of the Business Line Buildings that could possibly be reused and IT developments that support the reusability of project information.

If projects are turned in to products NSI knows that the value offered to the client and the revenue structure must change. NSI however needs insights on the effects of changing projects into products on the network of parties that contributes to the completion of project/product in terms of roles, but also risks. We performed a case study with the Karel Doorman Rotterdam project as subject to provide those insights. The Karel Doorman Rotterdam is a successful project of the business unit Hubs & Leisure in which an existing building is extended with an ultra light weight steel construction, which resulted in a 16 storey apartment complex on top of a shopping mall.

Our research question therefore is: *If NSI turns the Karel Doorman project into a replicable product, what is the effect on the network that contributes to the realization of the building in terms of roles and risks and what are the business consequences of this effect?*

From the literature study we performed we learned to place our research problem in the framework of business model literature. We now describe turning projects in to projects as a change in *value proposition* and *earning logic.* The network of contributing parties can be described as *value network,* in terms of business model literature. The literature study more gave us the foundations for a structured method that could describe and map *value proposition, earning logic,* and *value network* in terms of roles and risks. We combined several methods that we found in literature to a method that we called Roles and Risks Breakdown structure (RRBS).

After that we applied this method on the Karel Doorman case. We described the relevant elements of the business model of the Karel Doorman Rotterdam project and a future Karel Doorman like product with the help of the experts of NSI. We indentified roles and risks for the Karel Doorman Rotterdam project and a Karel Doorman like product and we subsequently quantified the risks for three different situations, namely: the Karel Doorman Rotterdam project, the first Karel Doorman like product, and the 5^{th}-10^{th} Karel Doorman like product. With the latter we mean the situation in which NSI has replicated the product several times. As an indication we took the 5^{th}-10^{th} time.

With the results of the case study we answered our research question. If the Karel Doorman project is turned into a replicable product the effect will be that the value network changes both in terms of roles and risk. The main change in terms of roles is the integration of 4 roles into 2 roles. One of those new roles becomes the largest role in the value network. This role, *the supplier of the Karel Doorman,* is to be filled in by NSI. The role of *project developer,* which was an important role during the project, is divided over the 2 new roles. The remainder of the roles stays the same when the project is turned into a product.

Our main conclusions regarding the risks in the value network are the decrease in the total amount of risk in the value network, especially when the product is replicated, and the shift of a lot of risks to *supplier of the KD product,* which is the role that NSI would fulfill. This is a much larger role than the role of *designer of the construction*, the usual role. Although the amount of major risks increases during the first Karel Doorman like product situation, the amount of major risks decreases when the product is replicated. Furthermore the largest risk NSI has to carry is less severe in the Karel Doorman like product situations compared to the Karel Doorman Rotterdam project situation.

The business consequences adhere to the larger role. NSI must adapt to this larger role in which they have to do activities that are outside their regular business activities, and therefore involves skills and capabilities that may not be present (yet). Since more risks are carried, another consequence is that NSI should put a lot effort in risk management. A very positive consequence of the larger role is that the portion of the network benefits should become larger as well.

Our conclusion is that the effects of turning a project into a product could be very beneficial for NSI and thus the company, if, and only if, NSI is able to adapt well to larger role in the product situation and the product is replicated several times. NSI should therefore focus on products that can be easily replicated several times, since the benefits increase and the risks decrease if a product is replicated several times.

Our recommendations for NSI include: replicating the RRBS in case of more information on the network of a future Karel Doorman like product, replicating the RRBS in other cases and for other value propositions and earning logics, storing risks that occurred, storing information on the performance of other parties in the network, critically considering the launching customer, updating the risks categories in the RRBS when needed, using the RRBS to negotiate for a large share of the benefits that the value network should divide, and above all obtaining the right skills and capabilities that are needed for fulfilling the role of supplier of the Karel Doorman product.

Major limitations of our research are: the limited view on the value network (the network was analyzed by one of the parties), the limited amount of experts that identified and quantified the risks (and roles), and the fact that we try to predict the future, which is uncertain per definition.

Our most important suggestions for further research include: testing the RRBS in other cases, testing the RRBS from the perspective of other parties in the network, testing the RRBS in other branches, investigating the exact relationship between the business model elements, and further investigating the business consequences of turning projects into products.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AEC	Architecture, Engineering and Construction (industry)
AHP	Analytical Hierarchy Process (risk assessment method)
ASEA	Australia and South East Asia (region)
BIM	Business Information Model
BL	Business Line
BM	Business Model
BU	Business Unit
B&U	Burgerlijke- en utiliteitsbouw (Dutch)
CAPEX	Capital expenditure
DA	Designer of the appearance of the building (role)
DC	Designer of the construction (role)
F	Financer (role)
I_I	Impact of risk I
KD	Karel Doorman
LO	Land owner (role)
MC	Main contractor (role)
MENAI	Middle East, North Africa and India (region)
M_I	Manageability of risk I
NSI	Business Unit New Strategic Initiatives
NVA	Network Value Analysis
OA	Other advisors (role)
OSB	Owner of substructure (role)
OSP	Owner of superstructure (role)
P-I	Probability-Impact method (risk assessment method)
P_I	Probability of risk I
PjD	Project developer (role)
PM	Policy Maker (role)
PMK	Project manager with local market knowledge (role)
PRM	Project Risk Management
(R)FMEA	(Risk) Failure Mode and Effects Analysis
RBS	Risk Breakdown Structure
RDM	Risk Diagnosing Methodology
RPN	Risk Priority Number (= probability * impact * detection)
RRBS	Risks and Roles Breakdown Structure
RS	Risk Score (= probability * impact)
SKD	Supplier of the Karel Doorman product (role)
SP	Supplier of planning permission (role)
TD	Technical development
WBS	Work Breakdown Structure

1 INTRODUCTION

This report is written in the framework of completing my Master programme Industrial Engineering and Management (Production and Logistic Management track) at the University of Twente. This research on turning projects into products was conducted at Royal HaskoningDHV. The aim of this first chapter is to introduce the reader to the company and the motivation for this research by introducing the problem. This chapter ends with section 1.3 which gives an overview of the outline of this research (and thus this report). We provided a List of Abbreviations on page xiv to support the reader in interpreting the abbreviations in the remainder of this report.

1.1 ROYAL HASKONINGDHV

Since this master assignment was conducted at Royal HaskoningDHV, this section provides some background information on the company and its organization structure.

According to the Annual Report 2014((Royal HaskoningDHV, 2014) *'Royal HaskoningDHV is an independent, international engineering and project management consultancy with over 130 years of experience. Our professionals deliver services in the fields of aviation, buildings, energy, industry, infrastructure, maritime, mining, transport, urban and rural planning and water.'*

In 1881 Royal Haskoning was founded (named 'ingenieursbureau J. van Hasselt & De Koning') by Johannes van Hasselt en Jacobus de Koning. International engineering consultant DHV was founded in 1917 by Dwars, Heederik en Verhey. In 2012 the two engineering consultants merged to Royal HaskoningDHV.

Royal HaskoningDHV has an average workforce of 7000 professionals spread over 100 offices in 34 countries. These professionals work for public and private clients in more than 130 countries. (Royal HaskoningDHV, 2014) Royal HaskoningDHV's head office is located in Amersfoort, The Netherlands, from which the largest part of this research was conducted. Royal HaskoningDHV 'focuses on delivering added value for its clients while at the same time addressing the challenges that societies worldwide are facing.'(Royal HaskoningDHV, n.d.) Therefore its guiding vision is 'Enhancing Society together'.

Royal HaskoningDHV organizes its consulting and engineering activities in separate business lines. These business lines include:

- Aviation
- Buildings
- Industry, Energy and Mining
- Infrastructure
- Maritime and Waterways
- Planning and Strategy

- Rivers, Deltas and Coasts
- Water Technology

Within these business lines multiple business units and advisory groups exist. Since this research was conducted at business line Buildings, the next sub section zooms in into business line Buildings.

1.1.1 BUSINESS LINE BUILDINGS

Business line Buildings focuses on creating sustainable buildings by using innovative technologies and focuses on several regions. These regions include Europe, the sub Saharan region, the MENAI (Middle East, North Africa and India) region, South East Asia, Antarctica and Australia[1] (ASEAN). Table 1.1 shows the amount of Buildings staff that is dedicated to a specific area and the market position (compared to its competitors) of Buildings in terms of turnover in (parts of) that region. The table shows that most staff is dedicated to Europe, which has lead to a leading market position. Moreover the ASEAN and Sub Saharan regions have a large amount of dedicated staff as well which gives the business line a noticeable market position in those regions as well.

Table 1.1: Focus regions of the business line Buildings

	Europe region	Middle East Northern Africa and India region (MENAI)	Sub Saharan region	Australia and South East Asia, Antarctica region (ASEAN)
# Staff	650	40	140	260
Market Position	#1 in the Netherlands	Unknown	#3 in South Africa	#3 in Thailand

Most important to the business line is to deliver environments that fit the client's needs. The business line is active in all stages of the building cycle which include initiative, design, development, management, and maintenance. The business line serves a broad line of markets, namely healthcare, arts & culture, education, corporate offices, research & development, mission critical facilities, transport hubs, commercial real estate, public & diplomatic, and sports & leisure. These markets are all characterized as complex markets. That complexity can be found in technological challenges or in the context of the market. Therefore elementary schools and housing are in general no part of the focus markets for the business line for example.

The business line Buildings aims for a global leading market position in three of its focus markets, namely: healthcare, research & development, and mission critical facilities.

[1] Business Line buildings is not actively involved in Australia, but they are heavenly involved in South East Asian projects. Furthermore they are active in Antarctica. There are other Business Lines that are working in Australia, therefore it is included in the regional divisions.

According to Royal HaskoningDHV's vision: '*leading market positions are related to profitability because of economies of scale – synergies drive effectiveness and efficiency – or because of market power. To stay ahead of the competition and hold these positions for the future, we continuously need to be recognised for our thought leadership and innovations'* (Royal HaskoningDHV).

All focus markets are divided amongst several so called global business units. Figure 1.1 provides an overview of the business units. The business units contain several local advisory groups which can be found underneath the name of the units.

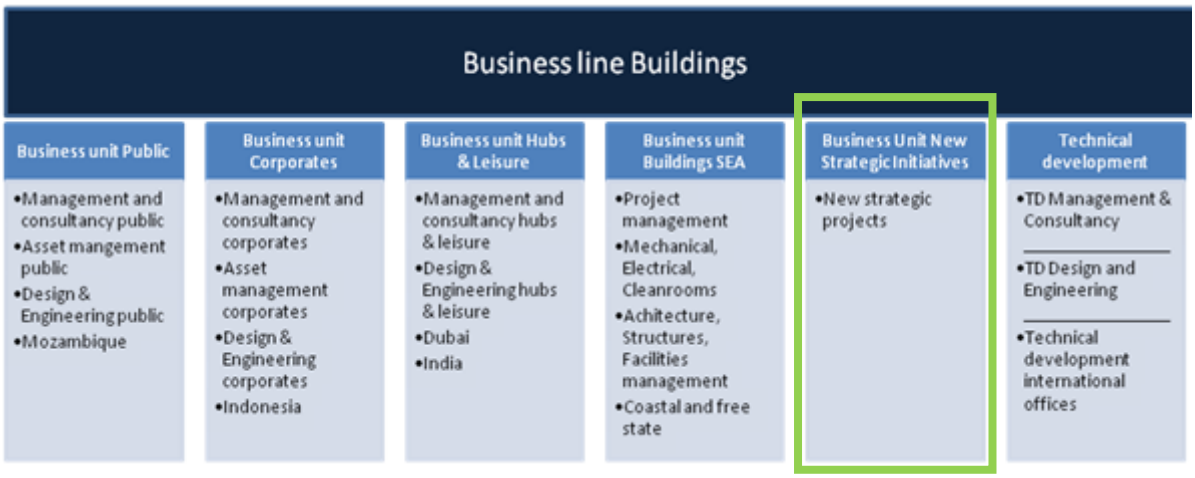


Figure 1.1: Business line Buildings with its business units and advisory groups

This research is conducted for the Business unit New Strategic Initiatives (from here: NSI). This recently started (January 2015) Business unit aims to accelerate the development of new products and services, based on new revenue models. The goal of this development is to find opportunities for new projects with higher profitability then projects with traditional revenue models. The business unit works in close cooperation with the other business units to identify opportunities for such new products and services.

1.2 INTRODUCTION TO THE PROBLEM

This section aims to introduce the problem to the reader. We start with an explanation of the changes in the way of working of the business line Buildings and the underlying logic of these changes. After that the problem becomes clear.

1.2.1 A NEW WAY OF WORKING

The business line Buildings has decided that a separate business unit, named NSI, will try to work in new ways with higher profitability than the standard way of working, which is based on project-based activities.

The BL Buildings operates within the Architecture, Engineering and Construction industry (from here: AEC) which can be described as a site-specific project-based activity. This leads

to a focus on individual projects and decentralized decision making and financial control (Cox & Thompson, 1997) (Dubois & & Gadde, 2002).

The new Business Unit NSI will leave the site-specific project-based activities and instead provide clients with products and solutions. The other business units of BL Buildings will still work in the traditional project-based way. The other business units are closely involved to NSI. NSI has 4 shareholders, namely the other business units. They provide equity and share in the profit of NSI.

1.2.2 DRIVERS FOR PROVIDING PRODUCTS AND SOLUTIONS

The decision to provide clients with scalable products and solutions is based on several drivers.

Profitability

First of all, the AEC industry is under great pressure. The crisis had led to a drop in building activities. To survive in this market, a way of working that can lead to higher profitability than the traditional ways of working would be helpful. The business line Buildings expects that higher profits can be gained by selling scalable products and solutions compared to the traditional way of working that is project-based and payment is done per hour worked. The scalability could for example lead to cost reductions due to learning effects and reuse of knowledge. Solutions become increasing standardized: in general 80% the same and 20% client specific, whereas the AEC industry has a history of 100% unique solutions per client.

Changes in clients' demands

Other important drivers are the changes in clients' demands. Clients today are more and more focusing on their core businesses to live up to the dynamics of the globalized competition and are therefore asking for integrated solutions with associated performance guarantees for their buildings.

Public clients are integrating their tenders as well. The maintaining and operating phase is for example included in those tenders in so called DBFMO contracts[2]. This seems to be a fair trend since a complex building will only benefit the client when this building is fully operating and supporting its primary process in a correct way.

This also leads to the need for reduced throughput times in the realization of buildings, since a building does not provide value before completion. It becomes even worse when the

[2] Design, Build, Finance, Maintain and Operate (DBFMO) contracts are a form of public private partnership that the government uses on building and infrastructure projects. In a DBFMO project, the government commissions a private consortium to build and operate a project, with the private party also arranging the project's financing. The government pays the consortium a fee for the project's availability throughout the entire term of the contract. The contract has a long term, often of up to 30 years (Algemene rekenkamer, 2013).

building does not perform when it is first operated. In that case the high building costs are not compensated for. That is an important reason for clients to ask for performance guarantees. A 'proven' product or solution instead of a new project might be very attractive to clients that need complex buildings.

The need for reduced throughput times is also fed by the IT developments in clients' organizations. Due to rapid developments in IT the organizations of the clients have developed rapidly as well. Therefore, the need for buildings that suit the clients' organization has become urgent.

1.2.3 ENABLERS FOR PROVIDING SCALABLE PRODUCTS AND SOLUTIONS

Besides drivers, there are also enablers that make it possible to provide clients with products and solutions.

Development within projects

One of the drivers for providing products and solutions is the fact that a lot of interesting development is done within the current projects of the business line. This means that new ways of building, for example the use of a light weight steel construction, are developed during a project for a specific client. When the project has successfully ended, this new knowledge and techniques are stored in a project file, or even end up as tacit knowledge[3] in project members' heads, even if the new technique is potentially useful in other projects. Some projects are even reusable as whole and can be turned into a product.

Within the business line buildings the scalability and reuse of a project is seen as a form of innovation. Figure 1.2 provides an overview of the vision on research, development and innovation within business line Buildings.

Figure 1.2: Research, development and innovation strategy within Royal HaskoningDHV and within business line Buildings

[3] Tacit knowledge (as opposed to formal, codified or explicit knowledge) is the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalizing it (Wikipedia, 2015)

Innovation is thus seen as successfully bringing developments to the market, which is exactly what NSI is doing. NSI collects promising project developments and investigates whether the development in that project would be replicable as a product.

IT supports reusability

An enabler which supports reusability of projects is IT development. In construction projects, a lot of information is stored nowadays in Building Information Models (BIM). These models support the reusability of projects. All useful information is stored in a systematic way and can be found at one (digital) location. Figure 1.3 is a graphical representation of the factors that are drivers for a change from projects to products (dark-blue) and the factors that are enablers for this change (green).

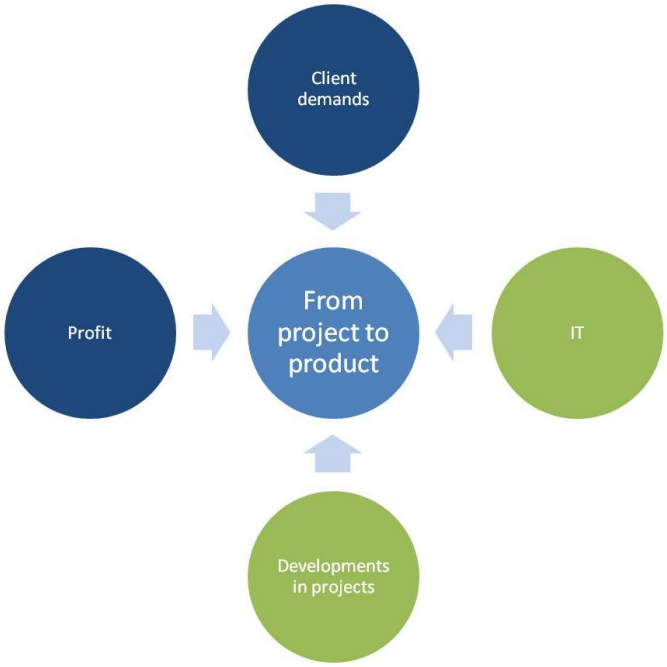


Figure 1.3: Graphical overview of drivers and enablers

1.2.4 MOTIVATION & PROBLEM DESCRIPTION

This sub section starts with an explanation of the changed earning logic as a consequence of providing a product instead of a project. After that, we introduce the uncertainties that NSI faces regarding to movement in which projects are turned into products. These uncertainties are the motivation for this research and form the problem description of our research.

Foreseen changes in selling products instead of executing projects

First of all, NSI knows for sure that the value that they provide to the end customer will change if they sell a product instead of conducting projects. For example, in a project the

outcome is never known beforehand by the end customer, whereas the end customer knows the outcome when a product is delivered.

Furthermore, NSI is aware of the fact that the new way of working has a consequence on the way in which revenues are captured. Traditionally, Royal HaskoningDHV (and thus, the business units of the business line Buildings), is paid by its clients based on the hours worked. The traditional revenue formula can be expressed as: *Revenue = Amount of hours worked * hourly rate.* However, since NSI aims to deliver products, not projects (worked hours), this revenue formula is not applicable. Therefore, NSI has to work with other ways of capturing revenues. NSI has decided together with the general management team of Royal HaskoningDHV that the following revenue models are feasible:

1. **Licensing**
   A client pays for the right to use the solution of NSI. This payment consists of a fixed sum that includes the license fee. In this case the profit for NSI= the fixed sum – development costs – proposal costs – the cost for working capital - legal costs for patents (if applicable).
   NSI could for example sell the right to use a technical development from a Buildings' project to a contractor that implements this development in one of its projects. Licensing is very common for software and music.
2. **Products with performance guarantees (managing contractor)**
   Selling of a (physical) product including services and performance guarantees. The price of the product includes the services. The profit for NSI is the price of the product- costs for the sales network – development costs – proposal costs – costs for working capital
   NSI could sell for example the result of a Buildings project as a product to a customer. The customer knows upfront what the product will look like and what is performance will be, since an example can be found at the end customer of the initial project.
3. **Sweat equity**
   This is applicable when a product or solution is developed with partners outside Royal HaskoningDHV. In this case NSI brings in equity investments in kind (not in cash) and becomes one of the shareholders of the product. The profit for NSI is a percentage of the profit (or, hopefully not, loss) that the entity of all shareholders makes on selling products.
   If NSI develops a solution or product together with other parties, they can set up a separate entity or contractual relationship in which NSI and its partners take part. They all become shareholder of this entity to a percentage that matches the initial investments in kind (hours spend on developing the solution or product). Products/solutions are sold by this separate entity and the profit (or loss) is divided between the shareholders according to their percentages.

The reason to choose from these three models is that these models are applicable to products, fit Royal HaskoningDHV's business model, and the risk profile of these models is acceptable to the general management team of Royal HaskoningDHV. Another important fit is in the amount of pre investment needed. Royal HaskoningDHV does not have the capital to heavily invest upfront; they, however, have a lot of human capital available.

Problem description

NSI expects that offering a product to the client instead of a project combined with the choice for one of these revenue models has an impact on the network of parties with whom NSI (or Royal HaskoningDHV) creates value for the customer. Traditionally, a project is conducted together for example with financers, project developers, contractors, and municipalities. All those parties take certain risks within the overall project. NSI expects that this network of parties will change in terms of roles and risks if NSI offers a product instead of a project (and thus hours). *However NSI is not sure in what way these roles and risk change.*

It is important to get insight in the roles and risks that will be present in a product situation; since this information is beneficial in deciding which role (and therefore which risks) NSI is willing to take itself. Furthermore it can be helpful in selecting the right parties to fulfill a role and therefore a certain risk. Our research aims to get insight in the roles and risks in the product situation. We translate the uncertainty regarding roles and risks in the network of parties that contributes to a future NSI product into a research objective and research questions in section 2.2. The problem on how to divide risk between several parties is an well-known problem in literature as well.

1.3 REPORT OUTLINE

In this section a short description of the remainder of this report is given.

The following chapter, Chapter 2, continues with the research plan to solve the problem of NSI. In this chapter we among others provide the scope of this research, research questions and the plan of approach. In Chapter 3 we present a theoretical framework that provides the information that is needed to come up with a solution for the problem of NSI. In Chapter 4 we elaborate on this theory by combining several theoretical sources into a useful mapping method that we need as we introduce in Chapter 2. In Chapter 5 we apply the knowledge that we obtained from theory to practice in the form of a case study on the Karel Doorman case which we introduce in Chapter 2 as well.

We present our conclusions of this confrontation between theory and practice in Chapter 6. This chapter continues with our recommendations; furthermore it discusses the limitations of this research and provides recommendations for further research.

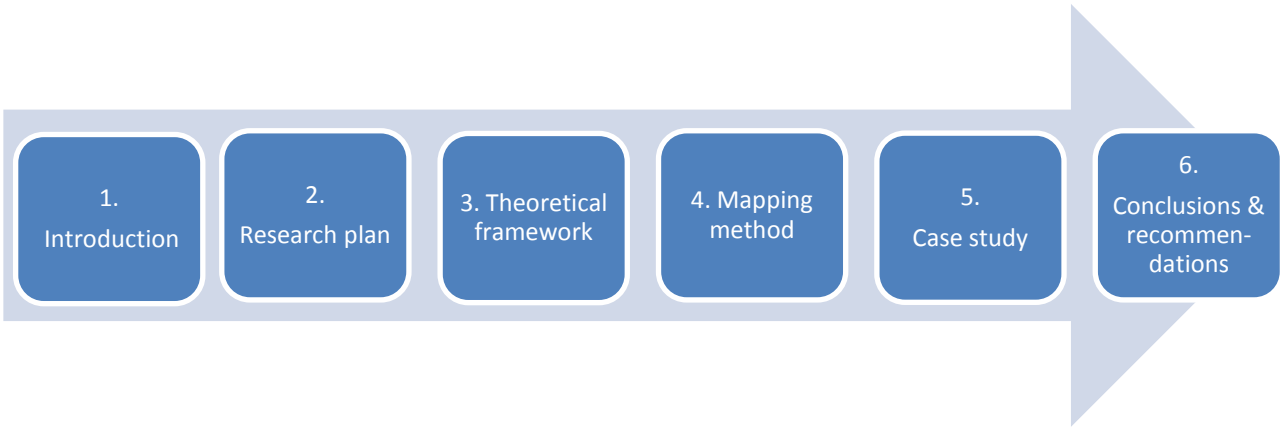


Figure 1.4: Chapter overview

Figure 1.4 graphically shows the outline of this report.

2 RESEARCH PLAN

In this chapter we provide a research plan to tackle the problem of NSI, which we introduced in section 1.2. This second chapter starts with section 2.1 in which we define the scope and context for this research. In this section we introduce the Karel Doorman case as well.

In section 2.2 we formulate our main research question and its corresponding sub questions. Section 2.3 introduces the research approach and in the last section, section 2.4, we will present the deliverables of this research project.

2.1 RESEARCH SCOPE

The range of projects that NSI likes to turn into products is broad. The ideas vary from floating islands to temporary parking garages. Per idea, the revenue model, but especially the network of parties will vary as well. Furthermore, our time is limited, so we have to limit our research scope. In this section we secure the scope of our research and we introduce our research context, namely the context of the Karel Doorman, one of the projects that NSI wants to turn into a product. The Karel Doorman functions as the real life case that we use in the remainder of this research.

2.1.1 SCOPE

Due to the fact that limited time and resources are available for this research, combined with the broad range activities the business line Buildings (and thus NSI) is involved in, a scope must be defined for this research. To be as specific and as practically useful as possible this research is bounded by a representative case. We have chosen the Karel Doorman as the representative case since the Karel Doorman was a traditional project in which useful and replicable knowledge was developed. These are the kind of projects that NSI likes to turn into products. Furthermore all information on the history of the project, the technological developments during the project, and the network of parties that contributed to the Karel Doorman project, is present within NSI.

Furthermore this research will solely focus on changes in roles and risks in the network of parties that contribute in completing the building. Other possible changes caused by a shift from project to product are left out of consideration.

2.1.2 THE RESEARCH CONTEXT

In this section we introduce one of the NSI cases, namely the Karel Doorman. NSI likes to turn this project into a replicable product. We use the Karel Doorman as the subject of our case study. After introducing the Karel Doorman project, we explain the context of this project, which thus forms the context of our research. We first elaborate on the industry and then on the sub sections of the industry in which the Karel Doorman project was performed.

Karel Doorman building Rotterdam

The Karel Doorman is successful project of the business unit Hubs & Leisure which was completed in 2012. The Karel Doorman is a 16 storey apartment block with a car park that is built upon a monumental shopping center in the middle of the city center of Rotterdam.

The technological developments in this project are described on the intranet of Royal HaskoningDHV (Royal HaskoningDHV, 2013) as follows: '*the engineers turned this idea into an audacious but feasible project: urban densification carried by hidden strength. A unique combination of thorough investigation of the existing structure, a clever lightweight design (only 250kg/m2) and on-site research and development of sound insulation and vibrations resulted in high quality apartments for a reasonable price'.*

Figure 2.1a and Figure 2.1 b give an impression of the Karel Doorman on top of the 'Ter Meulen' building, a monumental shopping center in the city center of Rotterdam. This project was a traditional project in which Royal HaskoningDHV (BU Hubs & Leisure) was paid in a traditional way as well, in other words, the engineering of the building was paid per hour worked.

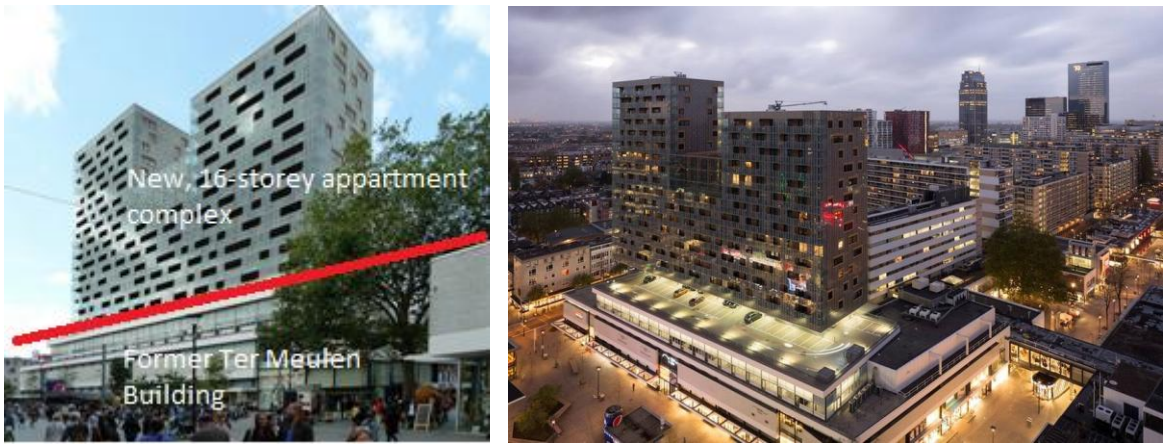


Figure 2.1 a & b: The Karel Doorman in Rotterdam seen from different perspectives

The construction of the Karel Doorman has won several prizes and can thus be seen as very successful development within a project. Therefore NSI aims to upscale the concept of the Karel Doorman into a product that can be put on the market. The offer to the client is then a product with an anchored outcome instead of a project. To that end, another revenue model must be applied, since the traditional payment per hour worked is not applicable. More on the development and history of the original Karel Doorman project can be found in Chapter 5.

The AEC industry

Royal HaskoningDHV, and thus NSI, takes part in the Architecture, Engineering and Construction industry (from here: AEC industry). IGI global (IGI global, n.d.) defines the AEC

industry as follows: *"The sector of the construction industry that provides the services on the architectural design, engineering design and construction services. It is a sector which is very active in the adoption of Information, Communication and Technology. This is also a sector which is very active in the international arena."*

Although the first part of this definition may sound evident, it provides some starting points for our literature study in Chapter 3, especially when another definition of the AEC industry is added. According to IMSCAD (IMSCAD global, n.d.) *"The architecture, engineering and construction (AEC) industry consists of separate players who work together to bring a project to fruition. By integrating these seemingly separate entities into a single industry, architects, engineers and contractors can work more efficiently to achieve a common goal."*

Important starting points that can be deduced from these definitions are the facts that the sector is project driven, part of the larger construction industry and active in an international playfield. For our literature research that means that we can search for literature in an international context (and is therefore not limited to the Dutch situation only). Research areas that might be interesting for our research are project management literature from all kinds of project driven industries and literature that is focused on the AEC industry or the construction industry.

Sub sections of the construction industry

The Karel Doorman Rotterdam project can be defined as part of the residential and non-residential construction sector (in Dutch: burgerlijke- en utiliteits bouw–B&U). The Karel Doorman concept can be used for as well residential buildings as well as non-residential buildings. Although the original Karel Doorman building in Rotterdam is an example of a residential building, it is also possible to apply the Karel Doorman concept for office construction for example.

It is, however, certain that the concept always involves high-rise building. Typical characteristics for this sub section of the construction industry, the high rise sector, are (Wikipedia, 2015):

- Design challenges for structural and geotechnical engineers, especially if the high rise building is build in a seismically active region or if the underlying soil has geotechnical challenges such as high compressibility
- Design challenges with respect to fire safety
- Studies are often required to ensure that pedestrian wind comfort and wind danger concerns are addressed. In order to allow less wind exposure, to transmit more daylight to the ground and to appear more slender, many high-rises have a design with setbacks
- Apartment buildings have technical and economic advantages in areas of high population density, and have become a distinctive feature of housing accommodation in virtually all densely populated urban areas around the world. In

contrast with low-rise and single-family houses, apartment blocks accommodate more inhabitants per unit of area of land and decrease the cost of municipal infrastructure

For the remainder of this research we keep in mind, and limit ourselves to, this context. The last characteristic is for example an important one in the light of the value that is provided to the client.

2.2 RESEARCH OBJECTIVE & RESEARCH QUESTIONS

This section starts with describing the objective of this research based upon the problem description in subsection 1.2.4. We continue with the research question and sub questions.

2.2.1 RESEARCH OBJECTIVE

The objective of this research is to get insights in the future roles and risks that will be present in the network of parties that are needed to deliver the end product to the client, when the result of the Karel Doorman project is turned into a product.

2.2.2 MAIN RESEARCH QUESTION

The main question of this research project can be conducted from the research goal and is as follows:

If NSI turns the Karel Doorman project into a replicable product, what is the effect on the network that contributes to the realization of the building in terms of roles and risks and what are the business consequences of this effect?

2.2.3 SUB QUESTIONS

To answer this research question, an answer on several sub questions must be found. These sub questions include:

1. *What is a suitable method to map the roles and risks in the network in a structured way?*
2. *What did the network in terms of roles and risks look like during the Karel Doorman project?*
3. *What roles and risks in the network of a future Karel Doorman product are expected?*
4. *What similarities and differences can we find if we compare the roles and risks of the project network and the future product network?*
5. *What are the business consequences of these changes?*
6. *To what extent can we generalize the results of the Karel Doorman case?*

The sub questions are related to each other. In Figure 2.2 this relationship is explained.

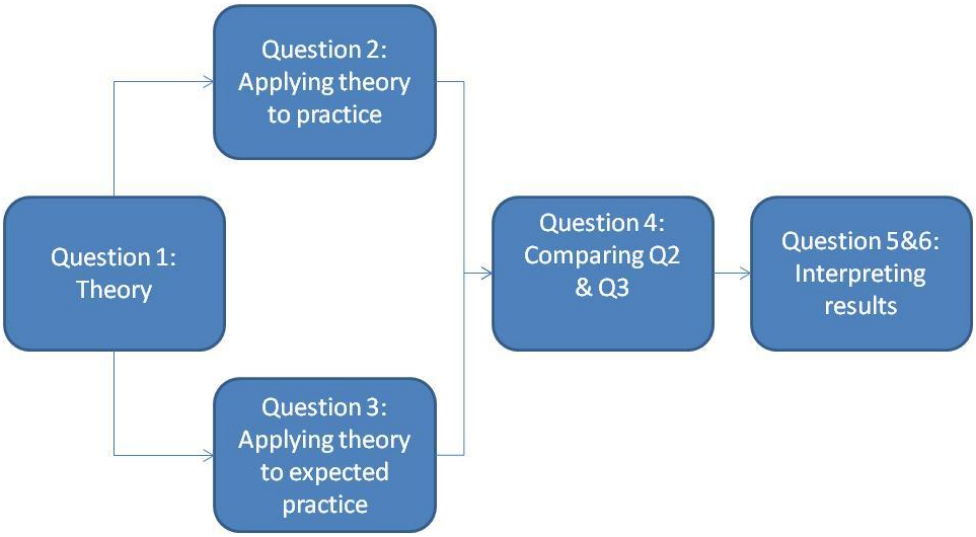


Figure 2.2: Relationship between the sub questions

2.3 RESEARCH APPROACH

This section discusses the plan of approach for the research.

First of all we conduct a literature study. The aim of this literature review is twofold. We aim to place the problem of NSI in the light of a theoretical framework and to find suitable ways to map the roles and risks of a network of parties. If such a method does not exist yet, we must design a suitable method for NSI based on the available literature on roles and risks our selves.

To make sure that a method is useful for NSI, we define criteria and preconditions for a method. The literature review answers sub question 1. During the search for relevant literature we make use of scientific search engines such as Google scholar, Web of Science, and Scopus. We only make use of literature that we can obtain without charge.

When the mapping methods are clear, we start with an explorative case study, namely the case of turning the Karel Doorman project into a product. The focus subjects of this case study are the roles and risks in the network of parties that realized the Karel Doorman Rotterdam project and the roles and risks that NSI expects in realizing a Karel Doorman like product in the future. By applying the mapping methods from the first question, this explorative case study answer sub questions 2 and 3. More explicitly we first reconstruct the roles and risks that were present during the Karel Doorman project and we then try to predict how a future Karel Doorman product looks like in terms of value to the clients, earning logic, and roles and risks in the network of parties that is involved in realizing in such a Karel Doorman product.

We apply the mapping methods on this case together with all the NSI members. All members of NSI are senior professionals that have dedicated a few days per week to the NSI activities. The members fulfill several roles within the business line, namely leading

professional, business development manager, business unit director, and strategic consultant. Furthermore we consult a risk expert of the business line Buildings to check whether our risk method complies with the vision on risk of the business line.

After the identification of the roles en risks for the Karel Doorman Rotterdam project and a future Karel Doorman like product, the NSI experts quantify the risks. In quantifying we assume that there are 3 situations.

- The first situation is the Karel Doorman Rotterdam project. The experts quantify the risks that we identified for the Karel Doorman Rotterdam project. From now on we call this situation the Karel Doorman project, or in short: KD project.
- The second situation is the situation in which the future Karel Doorman like product is delivered for the first time. The experts quantify the risks that we identified for the future Karel Doorman product as if it was the first time that this product is delivered. From now on we call this situation the 1st Karel Doorman product, or in short: 1st KD product.
- The third situation is the situation in which the Karel Doorman like product is delivered for several times already. To make this more explicit we assume that it is the 5th-10th time that a future Karel Doorman like product is delivered. The experts quantify the risk that we identified for the future Karel Doorman product. From now on we call this situation: the 5th-10th Karel Doorman product, or in short: 5th-10th KD product. With adding this third situation we are able to say something about the effect of the replicating a product.

The next step is comparing the outcomes of sub question 2 and 3. By comparing and analyzing the results of these questions we provide an answer on sub question 4. The interpretation of these results then gives an answer on question 5 and 6.

When all sub questions are answered, the main question is answered as well.

2.4 DELIVERABLES

In this section we describe the deliverables that follow from our research.

This research has two clear deliverables. First of all we provide a method to construct and map three important variables, namely *value for the client*, *revenue model*, and most the *network* of parties that are involved in delivering the end product. This network is described in terms of *roles and risks*.

The second deliverable is an in depth analysis of the expected changes in this network when the Karel Doorman project is changed in to a replicable product. We complement this analysis with the business consequences of the changes.

3 THEORETICAL FRAMEWORK

In this chapter we present the results of our literature study that aims to place the problem of NSI in a theoretical context and to provide a basis for a structured method to map roles and risks in the network that is involved in the total completion of a building project for the end customer.

In section 3.1 we start with the purpose and demands for such a method. We use the demands to structure our further literature review. In section 3.2 we introduce business model theory as the theoretical context of the problem. Section 3.3 treats the several methods that we found in literature and indicates whether they fulfill the criteria we established in section 3.1. This chapter concludes with our conclusions and a short summary.

3.1 A STRUCTURED APPROACH TO OBTAIN A SUITABLE METHOD

This section starts with introducing the purpose of the method that maps roles and risks in the network of parties that is involved in completing a building project for the end customer. After that we provide criteria and preconditions to ensure that the method we choose is suitable for NSI. We conclude with a framework that structures the remainder of this literature study.

3.1.1 PURPOSE OF THE METHOD

The purpose of the method is to provide a structured way in which the value that NSI offers to the client, the earning logic, and the network of parties in terms of roles and risk can be described and secured. We are especially interested to see which party caries what risks. Therefore the method must link identified risks to a certain role within the network. The structured and standardized way of working is helpful to compare different business models. In this research this comparison is made for a project which has already been executed and its corresponding product that will be developed in the future.

3.1.2 CRITERIA AND PRECONDITIONS TO FIND A METHOD THAT IS SUITABLE

To make sure that the method is suitable for NSI, the following preconditions and criteria are important to meet. These preconditions and criteria are approved (and seen as important) by the NSI BU Director.

- The method is structured.
- The method cannot be too time-consuming. Ideally, a half-day session is enough to execute the method.
- The method contains graphical representations where possible.
- The method must be reusable for, or easily adaptable to, other NSI initiatives.
- The method must be able to describe the business model of a former project as well as the future business method for the product variant to measure the effect of the

changed parts. If two separate methods for the past and the future are used, the outcomes would not be comparable.

- The method must be pragmatic and easy to understand for everyone in the company that may use the method in the future. A short description and a step by step approach must be enough to work with the proposed method.
- The method maps risks for all roles in the value network, not only the risks of the focal firm (NSI).
- The method should indicate major risks.
- The more familiar NSI already is with (part of a) method, the better.
- The method must cover not only the network in terms of roles and risks, but also the value NSI offers to the client and the earning logic.

3.1.3 APPROACH FOR THE REMAINDER OF THIS LITERATURE STUDY

To structure our literature study we make use of the criteria and preconditions as provided in the former subsection. For every method that we find in literature we fill in a score on the preconditions, criteria and completeness. Table 3.1 shows the format that we use.

Table 3.1 Scoring table for methods found in literature

Preconditions	Method 1	Method 2	Method …	Method N
Structured method				
Executable in a half-day session				
Reusable?				
Easily adaptable?				
Suitable for describing current and future business models				
Pragmatic and easy to understand				
Maps all risks in the value network not only the risks of the focal firm				
Indicates major risks				
Criteria				
Graphical elements where possible				
Familiarity with method				
Completeness				
Covers value to customer				
Covers earning logic part				
Covers roles in the network				
Covers risks in the network				

To decide which research field is interesting to search for methods, we first provide a theoretical context for the problem of NSI in the next section.

3.2 THEORETICAL CONTEXT OF THE PROBLEM

To come up with suitable methods for mapping the customer value, revenue model and network in terms of roles and risk, we first place the problem of NSI in a theoretical context. This provides some direction in which we must search for suitable mapping methods. We introduce the business model concept which places the problem of NSI in a useful theoretical context.

Within literature business models (BM) are a widespread and much mentioned way to describe the way in which companies do business. In the following subsections we investigate business models in depth.

These subsections aim to give insight in the current state of research on business models, try to give an overview of the status of several research areas that are linked to the concept of business models, but also to pinpoint existing research gaps. Most importantly we link our research problem to business model literature.

3.2.1 INTRODUCTION TO THE BUSINESS MODEL RESEARCH FIELD

The term business model was first mentioned in 1957 by Bellman et al. (1957). However, the concept of a business model did not get much attention until the end 1990's when the commercial internet boom took place (Magretta, 2002). Therefore the research field of business models is considered to be a young one (Burkhart, Krumeich, Werth, & Loos, 2011). The growing usage of modern information and communication technology based on the Internet in that time led to drastic changes in the economy and the nature of competition.

The competition of this 'new economy' became more global especially due to internet-based business activities. Business model became a buzzword, even in practice-oriented journals, and some emerging companies even thought that they neither needed a strategy nor any revenue resources as long as they had any Internet-based business model that would be considered as strategically well-placed (Magretta, 2002),(Teece, 2010), (Burkhart, Krumeich, Werth, & Loos, 2011). However, the dot-com hype could not last forever and the well known collapse of the dot-com bubble took place (Burkhart, Krumeich, Werth, & Loos, 2011). Among scientific researchers consensus exist that not the concept of business models itself, but its misinterpretation led to this collapse (Magretta, 2002). Since then, the concept gained more in-depth attention within (scholarly) journals. The in-depth interest in the concept is shown by the fact that the term is not only mentioned in the text, but also in the keywords of journal articles (Burkhart, Krumeich, Werth, & Loos, 2011).

Although the concept gained a lot of attention since the dot-com bubble, a lack of consensus and understanding exists in literature. Several different definitions of a business model can be found for example. In following sections an in-depth overview of the current literature on business models can be found. Burkhart et al. (2011) provide a research framework. In this

framework 5 research categories are presented. These are the categories in which business model research is conducted. The five categories are:

- Classification of the underlying literature
- Comprehension of business models
- Usage of business models
- Focus of business models
- Representation and evaluation of business models

In the remainder of this section we threat the comprehension of business models (definition and components), the usage of business models, the focus of business models, and representation and evaluation of business models (the latter three can be found in the subsection on different perspectives of business models). To that we add the gaps in the business model literature to show how our research contributes to business model research.

3.2.2 THE DEFINITION OF A BUSINESS MODEL

The lack of consensus on for example the definition of a business model is recognized by several researchers. Those researchers have tried to review the existing definitions of the term business model and aim to find some common themes. Zott, Amit and Massa (2011) provide a table with Business model definitions with their corresponding authors and the authors citing that definition.

An earlier study of Shafer, Smith and Linder (2005) does not only sum up definitions but also provides an overview of the components of a business model that are mentioned by several authors. They conclude that most of those components can be divided into four categories, namely: *strategic choices, create value, value network, capture value*. Burkhart et al (2011) dived into the definitions as well. First of all, they conclude that a difference in length exists among the definitions. They cite Timmers(1998), who provides a rather concrete and textual definition.

> *A business model is an architecture for the products, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues. – P. Timmers*

In contrast to that, according to Burkhart et al. (2011), there are authors that provide more abstract definitions that mostly consist of the components that a business model should describe. Another difference within the existing definitions can be found in the way they have been derived. An example of a rather semantic approach is according to Burkhart et al (2011) the definition of Osterwalder et al.(2005).

> *A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams. – Osterwalder et al.*

Other definitions are more derived from literature analysis in combination with the set up of some requirements (Burkhart, Krumeich, Werth, & Loos, 2011). An example that is mentioned in this category is the definition of Al-Debei et al. (2008). The requirements in this case are for example that the definition should be comprehensive and general applicable.

> *The business model is an abstract representation of an organization, be it conceptual, textual, and/or graphical, of all core interrelated architectural, co-operational, and financial arrangements designed and developed by an organization presently and in the future, as well as core products and/or services the organization offers, or will offer, based on these arrangements that are needed to achieve its strategic goals and objectives. – Al-Debei et al.*

Although many authors provided frameworks and analyses of the different definitions for business models, it seems that there still is no definition that will be used by all authors in the future. For our research the definition of Osterwalder et al. (2005) is suitable. This definition includes value to customers, earning logic and network of partners. Furthermore this definition assumes a relationship between the elements. This matches with the expectations of NSI.

3.2.3 COMPONENTS OF A BUSINESS MODEL

As touched in section 3.2.2 some authors define business models based on the components of such model. A lot has been written on components of a business model.

Shafer et al. (2005) have analyzed the literature on components and in the 12 selected definitions they found 42 components already. Luckily it seems that it is possible to find some overlap in literature. Remarkable is that almost all definitions include something that can be summarized as customer *value creation*. Second, the *earning logic* is mentioned as an important part of a business model. Business models thus aim to create and to capture value. The third element that is mentioned in most literature is the *value network of a company*. This element reveals the relationship that a firm has with various actors in its

value network. Finally, the *resources and capabilities* that a firm has and the types of *strategic choices* a firm makes are mentioned often (Nenonen & Storbacka, 2010).

Shafer et al. (2005) also identified four major categories in components of a business model. They distinguish: *strategic choices, creating value, capturing value, and the value network*. As can be seen those categories are very similar to those mentioned by Nenonen and Storbacka(2010).

Al-Debei and Avison (2010) indentified 4 dimensions as well: *value proposition, value architecture, value network, and value financed*. These also can be reduced to the categories that were proposed by the authors mentioned before.

The elements that are mentioned in literature the most are suitable to describe the problem of NSI. We can describe turning project to project in terms of business model literature as changing *the value proposition* (or value creation or creating value) and *earning logic* (or value capture or value financed). The risks and roles in the network of parties that contributes to the completion of the project together form the *value network*. The *Strategic choices* element of a business model is out of our research scope.

3.2.4 DIFFERENT PERSPECTIVES IN BUSINESS MODEL LITERATURE

The definition and components of a business model are not the only subjects in literature where a lack of consensus can be found or at least different perspectives exist on these subjects.

Level

A relevant theme in literature is the question on which level business models can be applied. In general (or in most definitions) the concept of business models is applied to the firm-level. On the other hand, there are authors, for example Magretta(2002), who state that business models should not be restricted to this firm- or business-unit level. According to, for example, Magretta(2002) and Chesbourgh and Rosenbloom(2002) a firm can have several distinct business models. Such models are designed at a much more detailed level (solution or product level) and can be helpful in innovation. The latter is confirmed by Teese(2010), who is even more radical by stating that *'every new product development effort should be coupled with the development of a business model which defines its 'go to the market' and capturing value strategies'*.
Kujala et al. (2010) even suggest in their work about business models in project-based firms that *'the analysis of business models needs to take place at the solution solution-level rather than at the level of the firm (or its business units) as is often suggested in literature'*.

In our research we adhere to the vision that the business models are applied on product or project level. We even assume that the business model for a project differs from its equivalent product business model.

Dynamic vs. Static nature

A discussion that can be found in literature on the comprehension of business models is for example the discussion on the static or dynamic nature of business model. The static view is that business models describe the current or future state of a company and its method for generating values. However, in the recent years, a more dynamic view is added to the business model concept. As a result more emphasis is put on research on change methodologies (Burkhart, Krumeich, Werth, & Loos, 2011).

We assume that a business model changes as one of the components changes. In real life this will often be the case. Therefore we adhere to the dynamic view.

Business model vs. strategy

In the research area on comprehension of business models another discussion can be found. Over the years researchers discussed on the link between business models and strategy (Burkhart, Krumeich, Werth, & Loos, 2011). Seddon et al (2004) provide an overview of the three differentiations that can be found in literature. These 3 include:

- Strategy = business model
- A business model is part of the strategy of a firm or vice versa
- Business models and strategy are more or less linked but are distinct concepts.

Analysis of Burkhart et al. (2011) shows that the latter is now commonly understood as the demarcation between strategy and business models. In our research we support this view as well. We focus our research on business models, not on strategy.

Focus

Remarkable is that in the research area 'focus of business models' consensus can be found. In all the literature reviewed by Burkhart et al. (2011) business models were understood as internally as well as externally focused. A business model covers business aspects outside the borders of the focal company. This is mostly reflected value proposition and value network part of a business model.

We support this view since our focus is internal (value proposition, earning logic) as well as external (value network, which contains roles and risks outside NSI/Royal HaskoningDHV).

Usage

With respect to the usage of business models Alt and Zimmermann (2001) describe three purposes of business models. These include:

- *Instance models* that represent the current business model to discuss and analyze this model
- *Type models* that describe types of business models

- *Simulation models* that are used to illustrate or analyze the future state of a company and its business orientations

According to the literature review of Burkhart et al. (2011) business models are mainly used as instance models. However, since more attention has been given to the dynamic properties of a business model, the business model is also used as simulation model to describe future business orientations. Type models are the least present in literature. They furthermore state that business models are used in the developing/operation stage, but also in the foundation stage. A business model can function as communication tool for investors in that stage, as well as for decision support.

In our research business models serve as instance model as well as simulation model. The mapping of the business model of a project can be seen as instance model, whereas mapping the future business model of the equivalent product can be seen as simulation model.

3.2.5 GAPS IN BUSINESS MODEL LITERATURE

Although lot of research was conducted on the subject of business models, research gaps are identified by several authors.

Al-Debei and Avison(2010) mentioned some shortcomings in current research. More research is needed on the components of business models including a research on the degree of importance of these components. Furthermore they see a knowledge gap on the relationship of business models and business performance. Another important issue they highlight is business model consistency of value network actors. Exploration on the benefits that actors within the same value network can gain through pursuing consistent business models might be fruitful.

Burkhart et al. (2011) define 5 major research gaps, which include:

- "Insufficient knowledge on business model components in particular regarding interdependencies within and between them
- Absence of formalized means of representations as well as procedure model to allow a structured and comparable visualization of business models.
- Limited insights on criteria and metrics for an appropriate evaluation of business models, which is mainly caused by the small quantity of (large-scale) empirical studies.
- Nonexistent software-based tool for the management of business model can be found so far, neither for visualization, evaluation or simulation purposes nor as a holistic approach
- Promote a common language and understanding of the concept to consolidate the work of different research streams"

The remainder of this research aims to resolve the first and the second research gap. To do so we first have to define the method that we use to map the three parts of the business model that lie within our research scope: *value proposition, earning logic, and value network.*

3.3 MAPPING (RELEVANT PARTS OF) THE BUSINESS MODEL

From section 3.2 we have learned that we could formulate our problem in terms of a business model. The aim of this section is therefore to provide methods to construct relevant elements of a business model. We score each method on the preconditions, criteria and completeness as we introduced in section 3.1. We start with methods that aim to map the business model as a whole. Since these methods do not fulfill all demands, we zoom in to the separate elements of the business model and present the methods that exist to map those separate parts.

3.3.1 MAPPING THE BUSINESS MODEL AS A WHOLE

Although a lot has been written on what business model are (and what not). It is hard to find literature on how to design or to map a business model. There are a few exceptions though.

First of all, business model components are seen as interdependent elements throughout literature. However it is hard to find a detailed analysis on how these components are interrelated. There clearly is a lack of knowledge what the impact is on the other component in case one of the elements has changed (Burkhart, Krumeich, Werth, & Loos, 2011).

A first hint on how to define or design a business model can be found in Chesbourgh and Rosenbloom(2002). These authors defined 6 attributes which together form a business model. These 6 attributes are:

- Value proposition
- Market segment
- Value chain
- Cost structure
- Value network
- Competitive strategy

In essence these 6 attributes do not differ that much from the earlier mentioned components in section 3.2.3. At least not in that sense that the attributes mentioned in that section are covered by these 6 attributes as well.

Chesbourgh and Rosenbloom (2002) furthermore state that in designing a business model, the first step is to define the value proposition. In other words defining the value created for users by the offering based on the technology. The second step is then to define the market segment, i.e. the users to whom the technology is useful and for what purpose. The third

step is to define the value chain *within* the firm. The value chain consists for example of creation and distribution of the offering. The assets that are needed in this chain should be defined in this step as well.

If the value chain is known the company should address how they will capture an appropriate portion of the value for itself. Therefore the cost structure must be investigated and the architecture of revenues must be defined. Chesbourgh and Rosenbloom (2002) mention some revenue models to obtain this, for example: sale, renting, licensing, and giving away the product and selling after-sales support and services.

The fifth step is creating the value network. According to Christensen and Roosenbloom (1995) delivering value to a client involves third parties, both within the vertical value chain, and from the value network. Defining this network is from great importance. When the focal firm is able to align with the value network, the value of the technology can increase. However if a focal firm fails to align with its value network, potential value can be lavished (Chesbrough & Rosenbloom, 2002).

Burkthart et al. (2011)investigated the ways business models were represented in literature as well. They remarkably conclude that in literature textual notations predominate and graphical representations are seldom found. This is striking, since expressing interrelated aspects in a textual manner is a heavy task. Furthermore, they state that to compare business models, either in a textual or a graphical way, a structured way of modeling is a necessity. However, in practice the process of modeling is often very creative, but unstructured and thus the models cannot easily be compared. Luckily some exceptions can be found in literature.

Business model canvas

After a comprehensive study on the subject of business models in 2004 in which Osterwalder proposed a business model framework containing several different elements, Osterwalder and Pigneur(2009) created a visual management tool, which can be used to design and describe business models. This tool is called 'the business model canvas' or the 'business model ontology'.

The business model canvas consists of nine so called building blocks. According to Osterwalder and Pigneur (2009) '*the nine blocks cover the four main areas of a business: customers, offer, infrastructure, and financial viability'*. To fill out the building blocks the authors provide questions that can function as guideline. Table 3.2 shows the building blocks and their corresponding questions.

Table 3.2: Building blocks and corresponding questions of the Business model canvas

Building block	Question(s)
Customer segment	For whom are we creating value? Who are our most important customers?
Value propositions	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? Which customer needs are we satisfying? What bundles of products and services are we offering to each Customer Segment?
Channels	Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?
Customer relationships	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How costly are they? How are they integrated with the rest of our business model?
Revenue streams	For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?
Key resources	What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?
Key activities	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams?
Key partnerships	Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?
Cost structure	What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?

In Figure 3.1 the Business model canvas can be found. In Appendix A, we provided a larger version for legibility reasons.

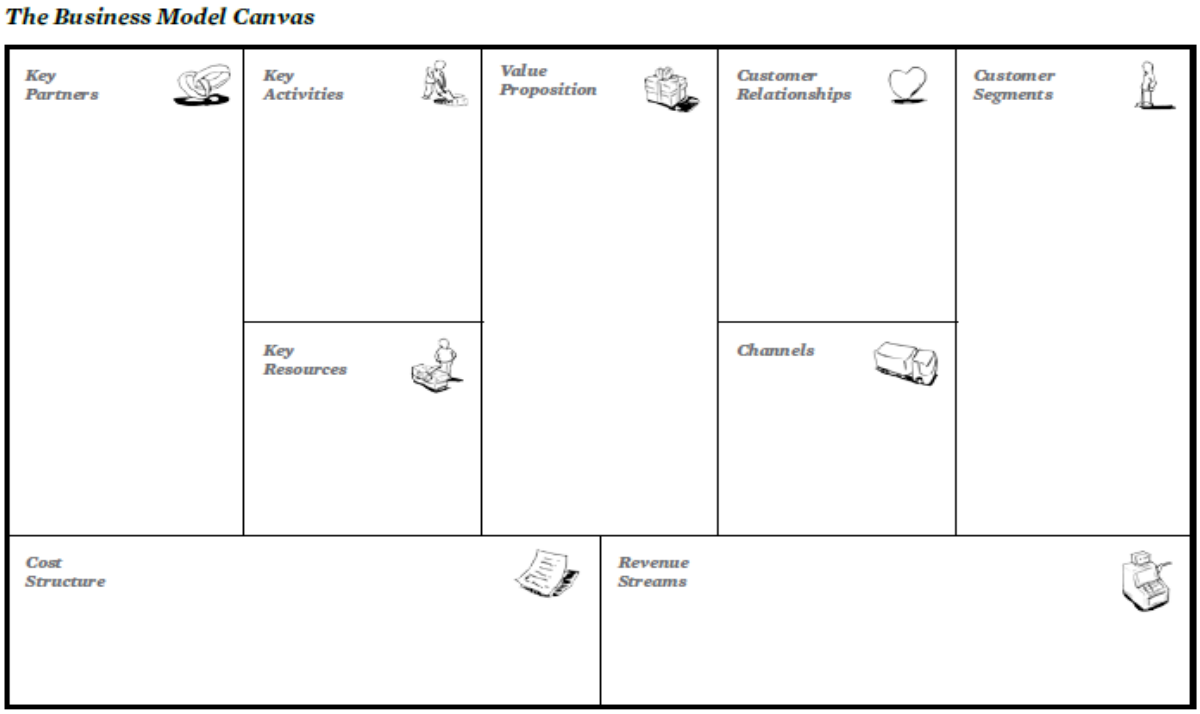


Figure 3.1: The business model canvas, source: (Osterwalder & Pigneur, Business model generation, 2009)

According to Fritscher and Pigneur(2009) '*the most interesting feature is the ability to describe the business logic of a company on one page: none of the individual elements of the business model canvas are new to business people. But the simple and yet holistic look at a business on a single page is surprisingly new to most of them*'.

They also evaluated the relationship between the building blocks and summarized that in to a figure. Figure 3.2 shows the building blocks and their relationships.

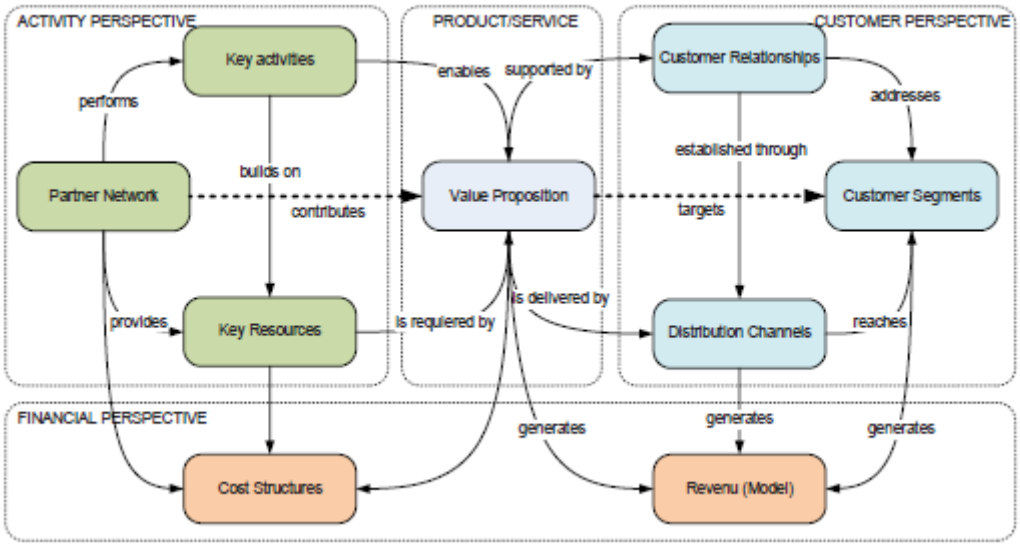


Figure 3.2: Relationship between the building blocks of the business model canvas (Fritscher & Pigneur, 2009)

Fritscher and Pigneur (2009) furthermore propose a process on how to work with the canvas. The first step is to mobilize people to generate new business opportunities. The second step is to understand the current situation using for example brainstorming, storytelling, visual thinking, scenarios, and customer insight. These techniques are helpful to regroup collected information and to pinpoint missing information. The third step is to design or extend the business model. Alternatives can be identified and finally the best alternative must be chosen. The fourth step is to implement the chosen business model. During this step storytelling can help to share vision. The last step is managing the current business model. The business model canvas could be used for monitoring the current situation. Table 3.3 shows the scores of this method on our preconditions, criteria and completeness framework. We conclude that the majority of this score is positive but some important parts are missing. We therefore still need to search for other methods.

Table 3.3 Scores of the Business model canvas

Preconditions	Business model canvas
Structured method	✓
Executable in a half-day session	✓
Reusable?	✓
Easily adaptable?	✓
Suitable for describing current and future business models	✓
Pragmatic and easy to understand	✓
Maps all risks in the value network not only the risks of the focal firm	×
Indicates major risks	×
Criteria	
Graphical elements where possible	±
Familiarity with method	++
Completeness	
Covers value to customer	++
Covers earning logic part	+
Covers roles in the network	±
Covers risks in the network	--

2-level method of Burkhart et al.

The Business model canvas is not the only method to describe a business model. Burkhart et al. (2012) investigated the existing methods for describing a business model. They evaluate these methods on several criteria. An overview can be found in Figure 3.3.

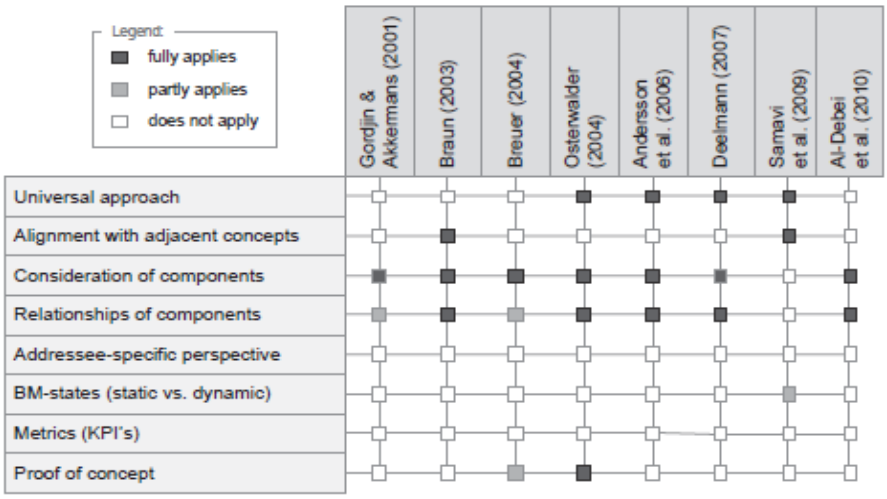


Figure 3.3: Several methods to describe a business model (Burkhart, Schief, Vanderhaeghen, & Wolter, 2012)

Some of these methods focus on e-business models or are only applicable for e.g. mobile services, and are therefore not a universal approach. The business model canvas however is a universal method. This also counts for three other methods. We zoom in into those methods.

The first of these methods is the method of Andersson et al.(2006). They constructed a method that was build op three other methods, namely Resource-Event-Actor (REA), Gordijn and Akkermans's (2001) e3-value and Osterwalder's(2004) first version of his business model canvas. It does not, however, tick more boxes than the methods it was build upon. Therefore we do not add this method to our framework.

The second is the method of Deelman, who carried out a research on the interaction between a business model and information systems of a firm. The third is the method of Samavi et al, which is called Strategic Business Modeling Ontology (SBMO). This method puts strong emphasis on the relationship of a company's strategy and its business model.

None of these methods however is able to tick more boxes than the business model canvas. So we do not add method 2 and 3 to our framework as well. Burkhart et al. (2012) conclude that their evaluation *'revealed a lack in aligning adjacent concepts with business models and considering business model evolution'*. Furthermore, they miss addressee-specific perspectives on business models as well as metrics or key performance indicators. Therefore they propose another method that consists of 2 levels. Level 1 shows the Meta-surroundings of a business model, see Figure 3.4

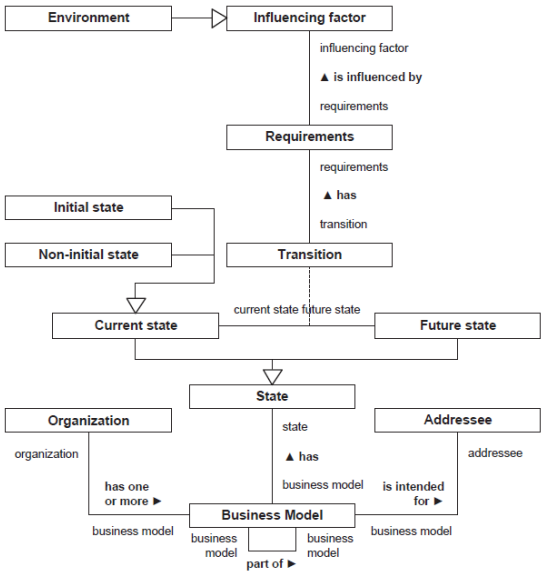


Figure 3.4: Level 1 of the method which shows the Meta surroundings of a Business model(Burkhart, Schief, Vanderhaeghen, & Wolter, 2012)

On the first level the ontology offers various addressee-specific perspectives. The state is incorporated to see how the business model evaluated over time. The second level describes the core elements and relationships within a business model. Compared to other methods, this level provides an extension on the value chain positioning and various strategies. Finally an important adjustment is the addition of performance measures (Burkhart, Schief, Vanderhaeghen, & Wolter, 2012). Figure 3.5 shows this second level. In Appendix A, we provided a larger version for legibility reasons.

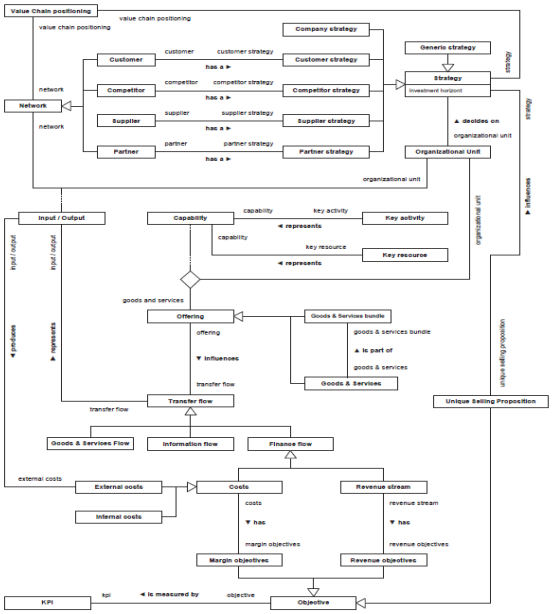


Figure 3.5: Level 2 to map the core business model ontology

Table 3.4 shows the scores of this method on our preconditions, criteria, and completeness. We conclude that this method fulfills fewer preconditions than the business canvas model. A

positive characteristic of this method is the graphical representation of the connections between the different elements. From the two methods that we described to map the business model as whole, the Business model canvas fulfills our demands the best. The major drawback however is the lack of emphasis on the risks within the value network.

Table 3.4: Scores the 2-level method of Burkhart et al.

Preconditions	Business model canvas	2-level method of Burkhart et al.
Structured method	✓	✓
Executable in a half-day session	✓	✓/×
Reusable?	✓	✓
Easily adaptable?	✓	✓
Suitable for describing current and future business models	✓	✓
Pragmatic and easy to understand	✓	×
Maps all risks in the value network not only the risks of the focal firm	×	×
Indicates major risks	×	×
Criteria		
Graphical elements where possible	±	+
Familiarity with method	++	--
Completeness		
Covers value to customer	++	++
Covers earning logic part	+	+
Covers roles in the network	±	±
Covers risks in the network	--	--

Since the method for mapping the business model as a whole do not fulfill all preconditions, criteria and completeness demands, we continue with describing methods to map the parts of the business model separately. We furthermore describe extended insights from literature per element. We put most emphasis on methods that describe the value network, since the Business model canvas is not capable to map the value network satisfactorily.

3.3.2 MAPPING THE VALUE PROPOSITION

Osterwalder and Pigneur (2009) define the value proposition as: *'the bundle of products and services that create value for a specific customer segment. The value proposition is the reason why customers turn to one company over another. The value proposition is an aggregation, or bundle, of benefits that a company offers customers. '*.

They continue by stating that there are several types of value propositions. '*Some Value propositions may be innovative and represent a new or disruptive offer. Others may be similar to existing market offers, but with added features and attributes.'*

The most logical way to express the value proposition is in a textual manner. The business model canvas (Osterwalder & Pigneur, 2009) provides questions that can be answered to eventually express the value proposition. These questions are:

- What value do we deliver to the customer?
- Which one of our customer's problems are we helping to solve?
- Which customer needs are we satisfying?
- What bundles of products and services are we offering to each Customer Segment?

A list of elements that can contribute to customer value creation is provided is well. This list is non-exhaustive, but exists by all means of the following elements:

- Newness
- Performance
- Customization
- "Getting the job done"
- Design
- Brand/status
- Price

For the value proposition part the business model canvas is a suitable method.

3.3.3 MAPPING THE EARNING LOGIC

As opposed to creating value for the customer the business model also contains a plan or description on how the company captures value for itself. The term earning model is used, but throughout literature several terms can found, such as 'revenue model, 'earning model', 'value finance', and 'cost structure and profit potential'. Johnson et al. (2008) define the earning logic (which is called Profit formula by these authors) as '*a blue print that defines how the company creates value for itself while providing value to the customers'*.

Chesbourgh and Rosenbloom(2002) state that the earning logic element should answer some questions, namely:

- How will a customer pay?
- How much to charge?
- How to divide the created value between customers, the firm itself and its suppliers?

They provide a few options for this earning logic, namely: outright sale, renting, charging by the transaction, advertising and subscription models, licensing, or giving away the product and selling after-sales support and services.

In the business model canvas (Osterwalder & Pigneur, 2009) the earning logic can be filled in at the building block 'Revenue streams'. To do so, Osterwalder and Pigneur (2009) provide questions that must be answered, namely:

- For what value are our customers really willing to pay?
- For what do they currently pay?
- How are they currently paying?
- How would they prefer to pay?
- How much does each Revenue Stream contribute to overall revenues?

Recalling from section 1.2.4 that NSI is limited to three revenue models next to its traditional model, there are just a few options here. We can describe these methods adequately making use of the business model canvas, however we should limit the answers to the questions to answers that are in line with the possible revenue models.

3.3.4 MAPPING THE VALUE NETWORK

According to Allee (2000) the traditional answer to the question: 'How is value created?' would be: 'through the value chain'. This is based on the value chain concept introduced by Porter(1985). However this is a form of thinking that is linked with industrial age production. Nowadays value is much more created through a value network or value web. Almost any firm or organization can be seen as a value network (Allee, 2000). Hamel (2000) a value network can consist of suppliers, partners, distribution channels, and coalitions that extend the company's own resources.

> *'The firm may be able to create unique relationships with any of these parties or even with its end customers. The role a firm chooses to play within its value network is an important element of its business model.' – G. Hamel*

According to Shafer et al. (2005) the value network is a component of a business model which contains information about Suppliers, Customer Information, Customer Relationship, Information flows and Product/Service flows. They furthermore warn for flawed assumptions about the value network. They state that a value network can change overtime, whereas a model sometimes mistakenly assumes that the existing value network will continue unchanged in the future. Peppard and Rylander (2006) confirm that a shift has taken place from a value chain perspective towards a value network perspective. *'With the value network concept'*, they state, *'value is co-created by a combination of players in the network'*. 'Adopting a network approach leads to a focus that is not on the company or the industry, but on the value-creating system itself, within which different actors work together to co-produce value. These actors can be suppliers, partners, allies and customers. It must be said that *'firms in the network are independent; otherwise they would fall into a case of vertical quasi-integration* (Peppard & Rylander, 2006)*'*.

In our research we focus on the network in terms of roles of the players. To the roles we add a dimension, namely the risks that each role has to carry. In business model literature

this extra dimension is not added, therefore we have to switch to (project) risk management literature as well.

3.3.4.1 ROLES WITHIN THE VALUE NETWORK

Zott and Amit (2009) *'conceptualize a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries'*. They provide an activity systems design framework. In that framework three design elements can be found.

1. Content: What activities should be performed?
2. Structure: How should they be linked and sequenced?
3. Governance: Who should perform them, and where?

NVA

Peppard en Rylander (2006) proposed a method called NVA (Network Value Analysis). This NVA method also includes analysis of the network. It consists of 5 steps.

1. Define the network/setting the boundaries of analysis
2. Identify and define network entities taking the standpoint of the network focal. '
3. Define the value each entity perceives from being a network member
4. Identify and map network influences/Define value linkages. Linkages that are suggested are: exchange of goods and services; affective and liking; information and ideas, influence and power; The linkages can either be direct or indirect and positive or negative with respect to value dimensions
5. Analyze and shape. A map is by definition static, as opposed to a network. Therefore in this step another layer is added that examines the behavior of the network.

An important note is that the network should contain roles or functions as nodes, not specific organizations (Peppard & Rylander, 2006). The authors furthermore link the network to the value proposition of the focal firm, as follows: *'we can define the network as consisting of all those actors or communities of people that exist in the network focal's current network environment that have a direct influence on, or are affected by, its value propositions towards customers'.*

In Table 3.5 we included NVA in our scoring table. As can be seen this method mainly contributes to the roles in the value network element. The risks in the value network are still lacking.

Table 3.5: Scores of the NVA

Preconditions	Business model canvas	2-level method of Burkhart et al.	NVA
Structured method	✓	✓	✓
Executable in a half-day session	✓	✓/×	✓
Reusable?	✓	✓	✓
Easily adaptable?	✓	✓	✓
Suitable for describing current and future business models	✓	✓	✓
Pragmatic and easy to understand	✓	×	✓
Maps all risks in the value network not only the risks of the focal firm	×	×	×
Indicates major risks	×	×	×
Criteria			
Graphical elements where possible	±	+	+
Familiarity with method	++	--	--
Completeness			
Covers value to customer	++	++	--
Covers earning logic part	+	+	--
Covers roles in the network	±	±	+
Covers risks in the network	--	--	--

Since the methods that we described so far have all in common that the risks that the parties in the value network face remains underexposed. We therefore zoom in on literature on project risk management. Some of the project risk management (PRM) literature is especially focused on the construction industry.

3.3.4.2 RISKS WITHIN THE VALUE NETWORK

Risk in construction projects has been an important factor to consider for decades. According to Latham (1994) no construction project is risk-free. *'Risk is manageable, diminishable, transferable or acceptable, but not ignorable.'* The construction industry is considered to be an industry with a high risk profile due to the nature of construction business activities, processes, environment and organization (Akintoye & MacLeod, 1996). More explicitly, the products of the construction industry are seen as complex and involve numerous stakeholders, long production duration and an open production system which entails interaction between internal and external environments (BSI-6079-4, 2006).

Therefore, much research is conducted on Risk Management in projects and risk allocation between parties. Decades ago Barnes (1983) already proposed an algorithm on dividing risks between contractors and clients for example.

'Risk can be broadly defined as a chance of danger, damage, loss, injury or any other undesired consequences'(Harland, Brenchley, & Walker, 2003). Sometimes risk is expressed as a formula. A quite simple formula is: *risk= probability of loss * significance of loss* which is found in for example Mitchell (1995).

Harland et al. (2003) performed a literature review and provide an overview of the types of risk that can be found in literature. This list includes: strategic risk, operations risk, supply risk, customer risk, asset impairment risk, competitive risk, reputation risk, financial risk, fiscal risk, regulatory risk, and legal risk. Table 3.6 shows these risks and their descriptions. This table is adapted from Harland et al. (2003).

Table 3.6: Risk types and their descriptions adapted from Harland et al. (2003)

Type of risk	Description
Strategic risk	A risk that affects business strategy implementation
Operations risk	A risk that affects a firm's internal ability to produce and supply goods/services
Supply risk	A risk that adversely affects inward flow of any type of resource to enable operations to take place
Customer risk	A risk that affects the likelihood of customers placing orders
Asset impairment risk	A risk that reduces utilization of an asset and can arise when the ability of the asset to generate income is reduced
Competitive risk	A risk that affects a firm's ability to differentiate its products/ services from its competitors
Reputation risk	A risk that erodes value of the whole business due to loss of confidence
Financial risk	A risk that exposes a firm tot potential loss through changes in financial markets
Fiscal risk	A risk that arises through changes in taxation
Regulatory risk	A risks that exposes the firm with changes in regulations affecting the firm's business, such as environmental regulation
Legal risk	A risk that exposes the firm to litigation with action arising from customers, suppliers, shareholders or employees.

Harland et al. (2003) furthermore discovered that *'there has been a variety of different focuses in research into risk management in purchasing and supply, but little in supply networks'*. The level of analysis in most studies does, however, not extend to look at supply chains and networks. According to Harland et al. (2003), there are some exceptions. They name Das and Teng (2001), who considered risk at the level of the inter-organizational relationship.

According to Flanagan and Norman (1993) risk management is '*as system which aims to indentify and quantify all risks to which the business or project is exposed so that a conscious decision can be taken on how to manage the risks'*. Within literature there is a general agreement on what is included in the process, however there are some differences in the level of detail and on the assignment of activities to steps and phases (Raz & Michael, 2001).

Boehm (1991) for example suggests that the PRM consists of two phases: risk assessment and risk control. Both phases include several steps, namely: identification, analysis and prioritization, and risk control during the risk assessment phase and risk management planning, risk resolution and risk monitoring planning, tracking, and corrective action during the risk control phase.

Fairley (1994) indicates seven steps during PRM: identify risk factors; assess risk probabilities and effects; develop strategies to mitigate identified risks; monitor risk factors; invoke a contingency plan; manage the crisis, and recover from crisis. These classifications find their basis in software literature.

Chapman and Ward (2004) propose a more generic PRM process. They pinpoint nine phases: define the key aspects of the project; focus on strategic approach to risk management; identify where risk might arise; structure the information about risk assumptions and relationships; assign ownership of risks and responses; estimate the extent of uncertainty; evaluate the relative magnitude of the various risks; plan responses and manage by monitoring and controlling execution.

In almost all of the cases risk identification is one of the first steps. For this research that is the most important step together with assigning ownership of risks. The remainder of this section will present methods that can be useful in executing these steps. To compare the risks in the network of the project situation with those in the product situation we need to say something about the magnitudes of the risks as well. We therefore need a risk quantifying method as well.

General methods for project risk identification

Chapman (1999) found out that a large number of techniques exist for risk identification. They name for example: brainstorming, checklists, questionnaires and interviews, Delphi groups, and diagramming approaches such as cause-effect diagrams. Hillson(2002) states that there is not one method that is absolute best for risk identification. Hillson(2002) argues that an appropriate combination of techniques should be used.

Mojtahedi et al. (2010) provide that several participants can be involved in the risk identification process, namely: project manager, project team members, customers, end users, other project managers, stakeholders, and risk management experts. Furthermore, Mojtahedi et al. (2010) conclude that the risk identification process usually leads to the qualitative risk analysis process or alternatively to a quantitative risk analysis process when conducted by an experienced risk manager.

Risk diagnosing methodology (RDM)

According to Keizer et al. (2002) the risk diagnosing methodology allows a firm to diagnose thoroughly and systematically the technological, organizational and business risks a project

faces, and to formulate and implement suitable risk management strategies. They argue that an activity should be labeled risky if: the likelihood of a bad result is great; the ability to influence it within the time and resource limits of a project is small; its potential consequences are severe. They furthermore state that there are four domains a risk assessment method can help to identify potential risks:

- Technology: product design and platform development, manufacturing technology and intellectual property
- Market: consumer and trade acceptance, public acceptance, and the potential actions of competitors
- Finance: commercial viability
- Operations: internal organizations, project team, co-development with external parties and supply and distribution

The authors warn for the bias that can be introduced by group decision techniques. *'People sometime hesitate to label factors as risky or not risky if opinion leaders within the group have a different view. One way to prevent these group effects is to collect potential risk factors individually from each member and then evaluate these factors the same way.'*

The RDM consists of 9 steps.

1. Initial briefing between the project manager and a neutral risk facilitator who is not part of the project team.
2. Kick-off meeting with the risk team, project managers and risk facilitator to ensure that everyone is aware of what is expected from them.
3. Individual interviewing of participants by risk facilitator to collect aspects of the project that are seen as risky.
4. Development of a risk questionnaire by the risk facilitator based on the interview results. The questionnaire consists of risk statements.
5. All respondents have to score the risk statements individually.
6. Constructing the risk profile by the risk facilitator.
7. Preparing a risk management session by the risk facilitator.
8. Risk management session where consensus on risks and action plan to deal with those risks is achieved. During this session the following rules of engagement are introduced: everyone's viewpoint is valid; no holding back; no management hierarchy; the thing we do not like to hear are probably key issues; explain from you area of expertise.
9. Drawing up and execution of a risk management plan.

The RDM was tested by Keizer et al. (2002). The RDM takes approximately 1.5 hours for project team members and 2.5 days for the project manager. The risk facilitator needs 6-8 working days. The method can be executed within 1-2 weeks.

Table 3.7 reveals that the RDM is the first method that covers the risks part. A major drawback is the amount of time that is needed to execute this method. Furthermore it focuses on the risks of the focal firm, not on risks of all parties in the network.

Table 3.7: Scores of the RDM

Preconditions	Business model canvas	2-level method of Burkhart et al.	NVA	RDM
Structured method	✓	✓	✓	✓
Executable in a half-day session	✓	✓/×	✓	×
Reusable?	✓	✓	✓	✓
Easily adaptable?	✓	✓	✓	✓
Suitable for describing current and future business models	✓	✓	✓	✓
Pragmatic and easy to understand	✓	×	✓	✓
Maps all risks in the value network not only the risks of the focal firm	×	×	×	×
Indicates major risks	×	×	×	✓
Criteria				
Graphical elements where possible	±	+	+	--
Familiarity with method	++	--	--	--
Completeness				
Covers value to customer	++	++	--	--
Covers earning logic part	+	+	--	--
Covers roles in the network	±	±	+	--
Covers risks in the network	--	--	--	+

Risk breakdown structure

According to Hillson (2003) most risk identification techniques produce an unstructured and long list of risks which does not help the manager in knowing where to focus risk management attention. Hillson (2003) states that *'in order to understand which areas might require special attention, and whether there are any recurring risk themes, or concentrations of risk, it would be helpful if there was a simple way of describing the structure of risk exposure'*.

Hillson (2003) therefore proposes a method that is based on the Work Breakdown Structure (WBS), which is a major project management tool. WBS is defined by the Project Management Institute (2001) as *'a deliverable-oriented grouping of project elements that organizes and defines the total work scope of the project. Each descending level represents an increasingly detailed definition of the project work.'*

Hillson (2003) argues that risk data can be structured and organized in the same way. The standardization of risk presentation is helpful for understanding, communication and management of the risks. Hillson (2003) refers to his earlier work in which he proposed en

defined the Risk Breakdown Structure (RBS), which provides a hierarchical structure of risk sources (Hillson, 2002b).

> *'RBS is a source-oriented grouping of risks that organises and defines the total risk exposure of the project or business. Each descending level represents an increasingly detailed definition of the sources of risk.' – Hillson (2002b)*

Hillson (2003) adapted work of Chapman (1999) as an example of an RBS for construction design. This example can be seen in Figure 3.6.

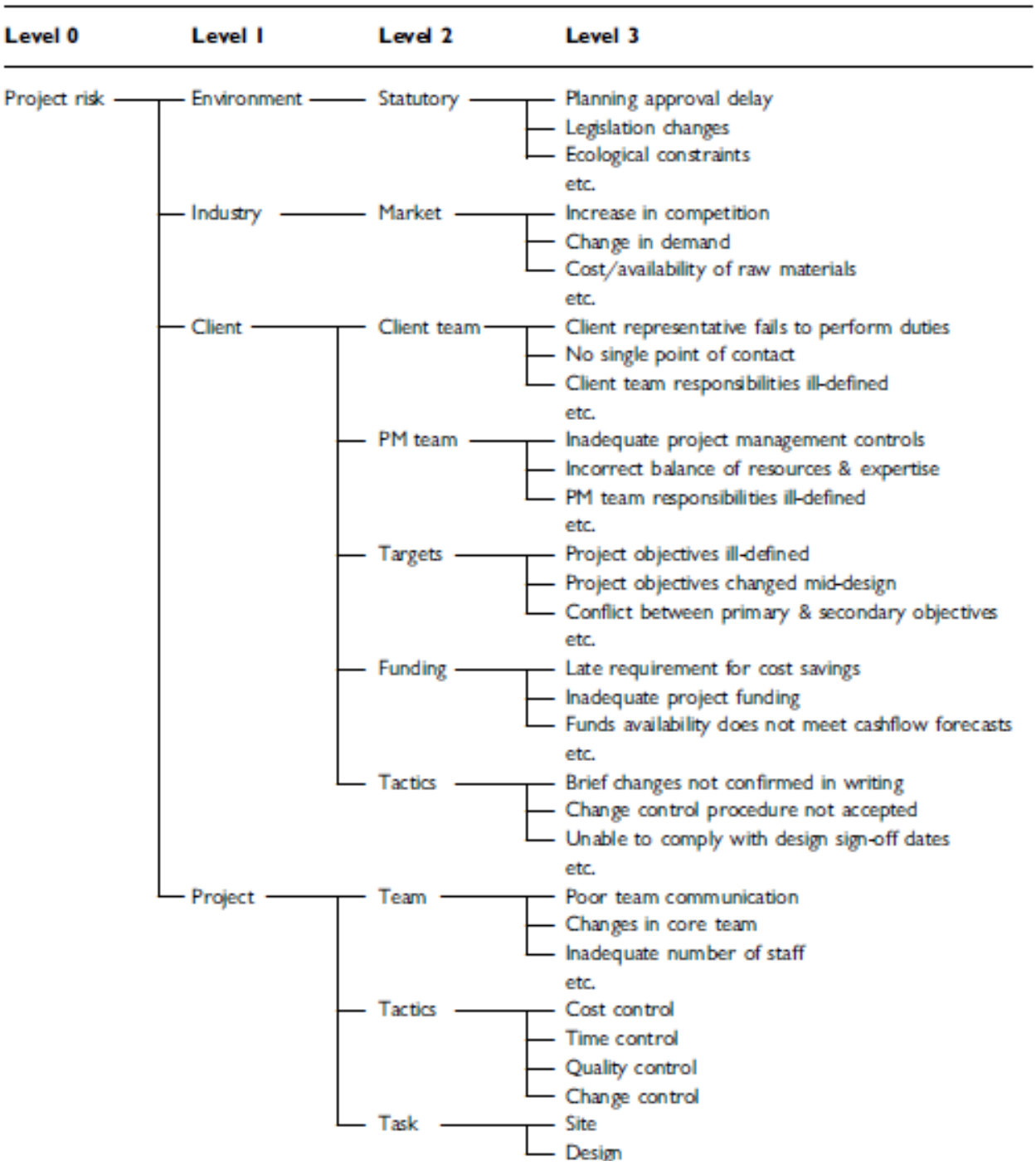


Figure 3.6: RBS example based on the work of Chapman (1999) obtained from Hillson (2003)

In Hillson (2003) more examples can be found, however, these generic versions can be used as starting point, but in most cases they will not cover all possible risks to every project. Therefore, the RBS should be shaped according to the specific needs of a particular project or project type (Hillson, 2003).

Hillson (2003) continues with the main uses and benefits of RBS. The first (and for this research most important) use is 'Risk identification aid'.

> *'The upper levels of the RBS can be used as a prompt list to ensure complete coverage during the risk identification phase. This is accomplished by using the RBS to structure whichever risk identifications method is being used. For example, a risk identification workshop or brainstorm might work through the various elements of RBS, perhaps at the first or second levels, encouraging participants to identify risk under each of the RBS areas. Similarly, the RBS major areas can be used to structure risk identifications interviews, providing an agenda for discussion between the facilitator and interviewees'. – D. Hillson (2003)*

If the RBS is complete, using the RBS to structure this risk identification process is an assurance that all common sources of risk have been taken into account. To overcome the problem of a RBS being incomplete, adding 'Other risks, not covered by the RBS', as a short additional risk identification effort, is an option (Hillson, 2003).

To identify what the most important sources are, one can simply count the amount of risks in each RBS area. This can however be misleading, since the severity of the individual risk in not taken into account. The measurement can therefore be improved by using 'risk scores' for individual risks. A well-known method is a P-I score, where numerical scores are given on probability (P) and impact (I), which then are multiplied to a risk score that reflects both factors. The risk concentration throughout the RBS areas can be estimated by adding the risk scores of all risks within an area and comparing those total risk scores (Hillson, 2003).

Table 3.8 shows that the RBS covers the risk part and performs well on most of the preconditions and criteria; however the coverage of other parts is negligible, and thus a concern.

Another concern is the absence of a clear method that reveals which risks are minor and which risks are major. Therefore we need a method that quantifies risks.

Risk quantifying

The subject of risk quantifying is broadly treated in literature. Studying all that literature in depth would be a whole new research itself. Luckily, Taroun(2014) did an excellent job in

reviewing the literature of construction risk modeling and assessment from the 1960's to recent work.

Table 3.8: Scores of the RBS

Preconditions	Business model canvas	2-level method of Burkhart et al.	NVA	RDM	RBS
Structured method	✓	✓	✓	✓	✓
Executable in a half-day session	✓	✓/×	✓	×	✓
Reusable?	✓	✓	✓	✓	✓
Easily adaptable?	✓	✓	✓	✓	✓
Suitable for describing current and future business models	✓	✓	✓	✓	✓
Pragmatic and easy to understand	✓	×	✓	✓	✓
Maps all risks in the value network not only the risks of the focal firm	×	×	×	×	×
Indicates major risks	×	×	×	×	✓/×[4]
Criteria					
Graphical elements where possible	±	+	+	--	+
Familiarity with method	++	--	--	--	±
Completeness					
Covers value to customer	++	++	--	--	--
Covers earning logic part	+	+	--	--	--
Covers roles in the network	±	±	+	--	-
Covers risks in the network	--	--	--	+	+

Taroun (2014) introduces several methods from literature such as: Monte Carlo simulation, Fuzzy sets theory, Probability-Impact models (P-I), Analytical Hierarchy Process (AHP), and all kinds of derivations of these basic methods. The author furthermore investigated the actual practice of risk assessment.

From this extensive review, Taroun (2014) concludes that he P-I risk model prevails. Despite its predomination the P-I model could use some improvements. Yet, the efforts for improvement have increased. The improvements most of the time consists of adding a factor to the model. Examples of such factors are: predictability, controllability, significance, manageability, exposure, and discrimination.

For our research we feel that the extent to which the role that owns the risk can influence or control the risk is very important next to probability and impact. This factor that we call manageability[5] can be used to decide which risks are the most important to focus on. Two

[4] Depends heavily on if and how the P-I scores are used. If applied, the P-I scores could be used to define a shortlist of major risks.

[5] The term manageability is used in many ways in literature; however, the term is used in this way within the BL according to the risk expert that we consulted.

risks can be equal in terms of probability * impact, it would however make a difference to what extend that risk is within the role's sphere of influence. There are only two options to deal with a risk that is without the role's influence, namely accept or transfer the risk, whereas for a risk that is within the role's sphere of influence a third option is to take mitigating actions to diminish the risk. Therefore we would argue that the first risk is more severe than the second.

From our consultation with a risk expert of the business line we learned that a within the business line a method called RISMAN is used. The RISMAN method is designed by amongst others Rijkswaterstaat and TU/Delft in 1995 and is since then broadly used in the Dutch infrastructure- and residential and non-residential construction sector (in Dutch: GWW en BU sector)[6]. Within the business line this method is used (together with clients as well). The risk assessment part is done making use of a method that is based on a probability and impact score as well. Manageability is sometimes scored but is not taken into account in the analysis, which is regretted by the risk manager. Therefore we search for a method that is able to take in to account this extra dimension.

A promising method is an extension of the Failure Mode and Effects Analysis (FMEA), namely the Project Risk FMEA as suggested by Carbone & Tippett(2004). The FMEA is a well-known technique used for process, design and service planning. In this technique scores for *occurrence* (probability), *severity* (impact), and *detection* are multiplied to obtain the so called risk priority number (RPN). Carbone & Tippett applied this technique to project risks by adjusting some aspects of the FMEA method. First of all the failure mode is replaced by a risk event. Second of all, the terms 'occurrence' and 'severity' are replaced by 'likelihood' and 'impact'. The largest adjustment is the definition of 'detection'.

> *'In the standard FMEA,the highest detection value means that the organization has no detection capability available for the fault, whereas a low detection number in the standard FMEA means that the organization has a way to detect the fault before it ships from the operation almost 100% of the time. For the RFMEA, detection techniques or method are defined as: the ability to detect the risk event with enough time to plan for a contingency and act upon the risk '– Carbone & Tippet (2004)*

We interpret the detection as the amount of control that the role has over a certain risk. To obtain control over a risk, the role must namely be able to detect the risk and act upon the risk as well.

Carbone & Tippet (2004) provide suggestions for analysis of the results as well. These suggestions, together with indentifying and quantifying risks, form an 8 step approach:

[6] For more information on RISMAN: www.rismantemp.nl

1. Identify Risk events
2. Assign Likelihood, Impact, and Detection value
3. Review RPN scores and determine a RPN critical value
4. Review Risk Scores (likelihood*impact) and determine Risk Score critical value
5. Review scatter plots for RPN vs. Risk Score
6. Determine intersection of Risk Score and RPN critical values
7. Develop risk response plan for Risk score and RPN critical values
8. Re-evaluate Risk Score and RPN based on Response plan

Table 3.9: Scores for RFMEA shows the scores for the RFMEA on the preconditions, criteria and completeness demands. We conclude that this methods ticks boxes that no other method did up until this point. However the method does not cover aspects of a suitable method.

Table 3.9: Scores for RFMEA

Preconditions	Business model canvas	2-level method of Burkhart et al.	NVA	RDM	RBS	RFMEA
Structured method	✓	✓	✓	✓	✓	✓
Executable in a half-day session	✓	✓/×	✓	×	✓	✓
Reusable?	✓	✓	✓	✓	✓	✓
Easily adaptable?	✓	✓	✓	✓	✓	✓
Suitable for describing current and future business models	✓	✓	✓	✓	✓	✓
Pragmatic and easy to understand	✓	×	✓	✓	✓	✓
Maps all risks in the value network not only the risks of the focal firm	×	×	×	×	×	×
Indicates major risks	×	×	×	×	✓/×[7]	✓
Criteria						
Graphical elements where possible	±	+	+	--	+	+
Familiarity with method	++	--	--	--	±	+
Completeness						
Covers value to customer	++	++	--	--	--	--
Covers earning logic part	+	+	--	--	--	--
Covers roles in the network	±	±	+	--	-	-
Covers risks in the network	--	--	--	+	+	++

[7] Depends heavily on if and how the P-I scores are used. If applied, the P-I scores could be used to define a shortlist of major risks.

3.4 CONCLUSIONS AND SUMMARY

Before we continue with chapter 4, we provide a short summary and conclusions of our literature review.

Summary

In section 3.1 we started our theoretical framework with an introduction of a structured approach to fulfill the goal of our literature review: finding a method to describe and secure the value that NSI offers to the client, the earning logic, and the network of parties in terms of roles and risk in a structured way, such that we can compare those elements for a project and product situation. The structured approach contains a list of criteria, preconditions and demands for such method which we fill out per method found in literature.

In section 3.2 we introduced a theoretical framework in which we placed our research problem. That framework is business model theory. We can describe the value offered to the client as *the value proposition* (or value creation or creating value) in terms of BM literature. The revenue model is the *earning logic* (or value capture or value financed). The risks and roles in the network of parties that contributes to the completion of the project together form the *value network*.

In section 3.3 we continued with the search for suitable methods. We started with methods to describe the business model as whole, we then continued with methods to describe the separate elements that we need for our research problem. For value proposition and earning logic the business model canvas provided a solution. For the value network we dived deeper in to literature. We separated the value network element into roles and risks and found some promising method, especially in project risk management literature. We scored all methods on our list of demands, preconditions, and criteria.

Conclusion

We conclude that placing our problem in the framework of business models gives us a structured and scientific view on our research problem. A lot has been written on business models, however none of the methods that we are aware of, is fully fulfilling our needs and demands, and therefore our theoretical framework does not give a complete answer on our first sub question. We must combine some methods in the next chapter to be able to answer that question satisfactorily.

4 SUITABLE MAPPING METHODS

From the last chapter we concluded that the methods found in literature do not solely fulfill our research purposes. In this chapter we therefore present a suitable method to map the value proposition, earning logic, and value network (in terms of roles and risks) based on the methods that we found in literature. This chapter gives an answer to the first sub-question: '*What is a suitable method to map the roles and risk in the network in a structured way?*'

4.1 METHOD FOR NSI

In this section we propose a method that is suitable for NSI. We start with a step by step construction of a suitable method and we end with an overview of the proposed method and instructions on the execution.

In literature we found several mapping methods. We presented these methods in section 3.3. None of these methods solely complies with the preconditions and/or complies with the exact purpose, as we showed in Table 3.9. From the completeness section of this table we learn that none of the methods is complete for the purpose of our research. Furthermore we conclude that none of the methods meets all preconditions either. Therefore, we merge and adapt some of the methods. This results in the method called Risks and Roles Breakdown Structure (RRBS) that we describe in the following sections.

4.1.1 DESIGNING A SUITABLE METHOD STEP BY STEP

The Business model canvas as a starting point

As a starting point for the method we take the business canvas model. There are several reasons for that. First of all, the method structures the broad business model concept. Secondly, NSI is familiar with the business canvas model. Furthermore, it is together with the 2-level method of Burkhart (from now 2-level method), the most complete method. If we can manage to add a structured way to describe roles and risks, the method has the potential to meet all preconditions.

The existing business model canvas is suitable to describe the value proposition and the earning logic. However, remind that NSI can choose between a limited number of revenue models, which we have described in section 1.2.4.The result of using the business model canvas a method to describe the value proposition and earning logic is a textual description based on the answers of the corresponding questions. From section 3.3.1 we have learned that the value proposition should be defined first. The earning logic follows.

Extending the canvas with value network Roles

Since we are interested in the roles and risk within the value network, we must define a structured way to map these. The current business model canvas does not explicitly describe

all roles and certainly does not describe the risks that are present per role. Some roles can be defined using the canvas though. Within the current canvas one could describe for example partners, suppliers and enablers, but these are all separate parts of the canvas whereas we are looking for an integrated part that describes all roles, preferably in a graphical and structured manner.

In literature we found a method called NVA, which we described in section 3.3.4.1. In our method we use most parts of this method. However, we slightly adapt the NVA method by adding a step suggested by Zott &Amit(2009), see section 3.3.4.1. We namely first set the boundaries of the system, which is the first step of NVA.

Then, if necessary, we add a step that cannot be found in NVA, but is important in the activity systems design framework of Zott & Amit(2009). In this step, the activities that must be performed by the network are defined. These activities can be used to investigate who (in terms of roles not specific parties) should perform a certain activity.

This automatically leads to the third step in which we identify roles from the focal firm perspective. For the purpose of our method we now have the information that is needed. Combined with the precondition that our method cannot be time consuming, we do not execute the other steps of NVA.

Linking Risks and Roles with the RRBS

In the former step of our method we extracted the roles in the value network. However, there is still an important part missing, namely the risks that the roles carry. We therefore need a structured way to indicate risks and link those to a role. For this purpose we propose a Risk Breakdown Structure, as introduced in section 3.3.4.2, in which the defined roles form level 1.

Level 2 will be formed by risk types that are applicable and important for NSI. Recalling from section 3.3.4.2, we know that the risk types that can be found in literature include: strategic risk, operations risk, supply risk, customer risk, asset impairment risk, competitive risk, reputation risk, financial risk, fiscal risk, regulatory risk, and legal risk.

For NSI, we propose to include the following risk types:

- Financial risk: all risks that deal with financial streams, investments, capital expenditure (CAPEX) and changes in financial markets
- Input risk: all risks that negatively affect inward flows of resources. This can include material streams, but also **information streams**
- Reputation risk: all risks that deal with loss of confidence in (a certain party of) the value network

- Legislation and regulation risks: all risks that deal with legal, fiscal and regulatory aspects, such as changes in taxation, environmental regulation or litigations from customers, suppliers, shareholders or employees

To these risks that are based on Harland et al. (2003). However, we add two more relevant risk types for NSI:

- Technical risks: all risks that deal with technical aspects of the building/object
- Other: all risks that cannot be categorized as one the other risk types

The third level is the level where the actual risks are defined. The proposed RRBS for NSI can be found in Appendix B. These risks are obtained by group brainstorming.

Quantifying and analyzing risks making use of RFMEA

To the RRBS we add a dimension to score the identified risks. The scoring method we propose is based on RFMEA. All risks must be scored on *probability* (likelihood), *impact*, and *manageability*. Table 4.1 shows the scoring options for each risk dimension. In general it could be said that a low score is positive for the risk owner.

Table 4.1: Scoring system

Score	Probability (P)	Impact (I)	Manageability (M)
	The chance of occurring	*Impact if risk occurs (on duration, quality, costs, safety, process, etcetera)*	*Influence and control over risk by corresponding role*
1	chance ≤1%	Very low	Within total control
2	chance >1% ≤5%	Low	Almost within control
3	chance >5% ≤20%	Medium	Within influence
4	chance >20% ≤50%	High	Some influence
5	chance >50%	Very high	Fully outside influence

To analyze the differences between the roles and risks in the value network of several business models (in our case the project and product situation), we calculate two indicators per risk (those risks are called risk events in the RFMEA method), namely:

1. Risk Score for risk i = Probability$_i$ * Impact$_i$, in short: $RS_I = P_i * I_i$
2. Risk Priority Number for risk i = Risk Score$_i$ * Manageability$_i$, in short: $RPN_i = RS_i * M_i$
   This is in fact the same as: $RPN_i = P_i * I_i * M_i$

4.1.2 OVERVIEW AND EXECUTION OF THE PROPOSED METHOD

In short the method we propose consists of 5 steps:

1. Define the value proposition making use of the business model canvas
2. Define the revenue model making use of the business model canvas and the three prescribed choices
3. Define the roles making use of the adapted version of NVA
4. Define the risks per role making use of a Risk Breakdown Structure
5. Quantify and analyze risks making use of the adapted version of RFMEA

These steps are conducted during brainstorm sessions with (all) NSI members. The researcher prepares the session (after testing the method one of the NSI members can fulfill this role) by restating the value proposition and revenue model (in the business model canvas) and leads a group brainstorm session on roles and risks. We make use of some principles from the Risk Diagnosing Method (see section 3.3.4.2). First of all, during the brainstorm session the rules of engagement are followed: everyone's viewpoint is valid; no holding back; no management hierarchy; the thing we do not like to hear are probably key issues; explain from you area of expertise. Secondly, the role of the risk facilitator (preparing and leading the risk session) is based upon the RDM as well.

The session starts with a short introduction of the methods and a recap of the value proposition and revenue model. Then the adapted NVA is conducted. First the network boundaries are set. Then the activities are mapped, followed by the corresponding roles. When consensus within the team is reached on the roles that are present in the value network, it is time for a short break. The researcher (risk facilitator) includes the defined roles in the RBS and takes care of a visible version of the RBS, that is now turned into a RRBS. This can either be slide that is projected with a beamer, a printed paper version, or a written version on a whiteboard/blackboard.

After this break the researcher (risk facilitator) elucidates the risk types and the RRBS. The risk types are open to discussion, if the group feels that a certain risk type is missing for the special case of that session, this type can be added. A brainstorm session on the risks can start now. The first step is to collect all risks the group can think of at level 3. The researcher (risk facilitator) writes down all risks at the right place in the RRBS. After that, the group decides which of these can be seen as major risks. When this is completed the group session ends. The researcher (risk facilitator) takes care of the administration and sends the results of the session to all members within one week after the group session.

For quantifying the risks, there are two options. The first option is to score the risks together during the risk session. An advantage of this option is the consensus that must be found on the scores and that it is certain that everybody understands and interprets the risk equally. The major drawback of this option is that it is time consuming, especially when there initially is a lack of consensus on the scores.

The second option is to score the risks individually by making use of an excel-template. The advantage of this option is the flexibility. Everyone can do this when it suits his (or her) time schedule. Furthermore it is less time consuming than the first option since no consensus is needed. The risk facilitator can take averages. The latter is also a drawback since it could be the case that a lack of consensus is caused by different interpretations of the risk, which stays uncovered when taking averages.

Regardless of the option that is chosen, the risk facilitator should analyze the risk scores and secure this in a risk file. The risk facilitator informs all members on these analysis results. The result of this analysis is at least a list with the major risks per party and for the total value network, which we can obtain by executing the following analyses:

1. Review RPN scores and determine a RPN critical value
2. Review Risk Scores (likelihood*impact) and determine Risk Score critical value
3. Review scatter plots for RPN vs. Risk Score
4. Determine intersection of Risk Score and RPN critical values

Table 4.2 shows the scores of the proposed method, RRBS, on the preconditions and completeness criteria. We conclude that this method complies with all requirements. We did not score the method on the criteria as we did with all the separate methods in section 3.3, since these criteria were used to choose between alternative methods.

Table 4.2: scores of the RRBS on the preconditions and completeness

Preconditions	RRBS
Structured method	✓
Executable in a half-day session	✓
Reusable?	✓
Easily adaptable?	✓
Suitable for describing current and future business models	✓
Pragmatic and easy to understand	✓
Maps all risks in the value network not only the risks of the focal firm	✓
Indicates major risks	✓
Completeness	
Covers value proposition part	++
Covers earning model part	++
Covers Value Network part (roles)	++
Covers Value Network part (risks)	++

Figure 4.1 is a graphical representation of the method that we propose for NSI to map the *value proposition, earning logic* and *value network* in terms of roles and risks for a project or product.

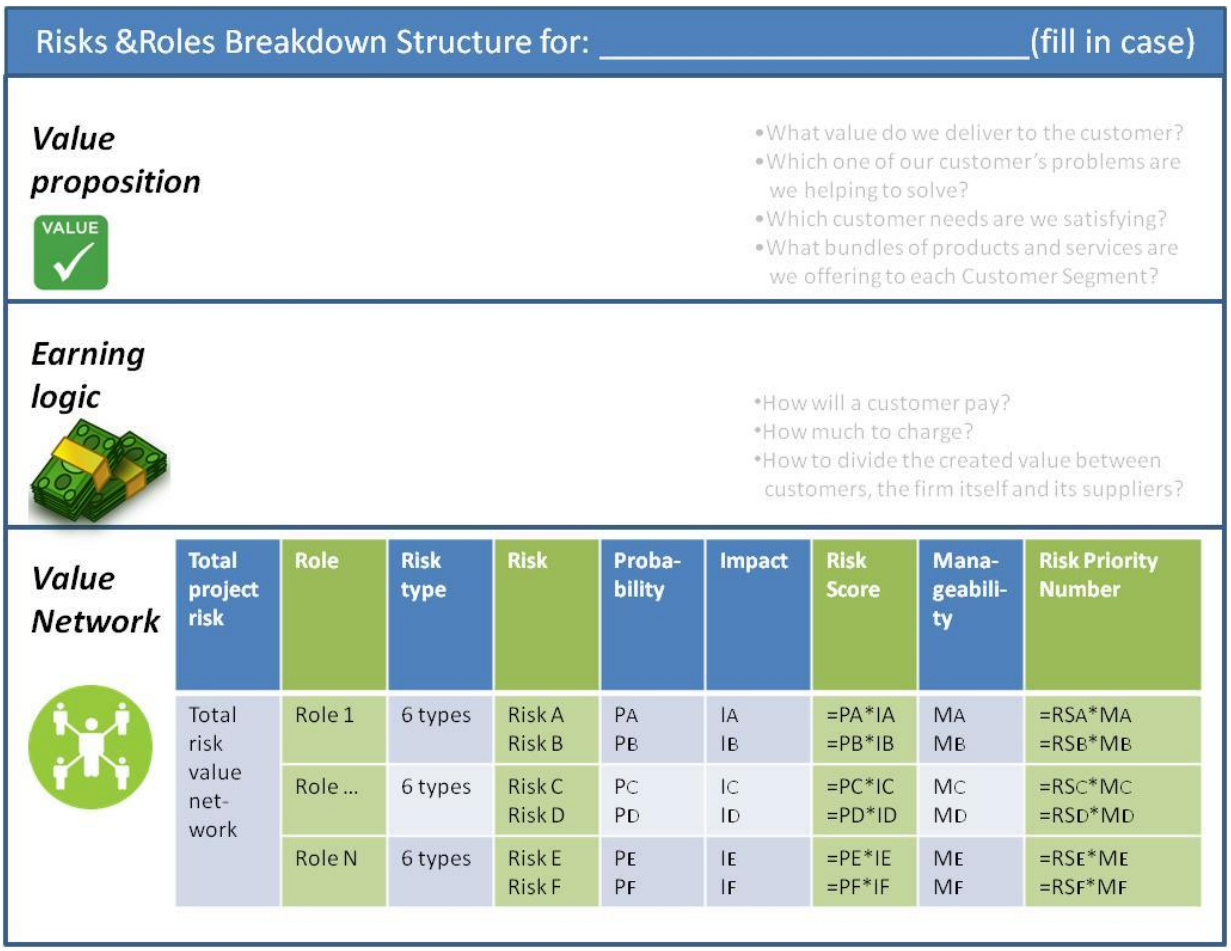


Figure 4.1: Overview of our proposed method RRBS

Remind that:

P_i = probability of risk i
I_i = impact of risk i
RS_i = Risk Score of risk i = $P_i * I_i$
M_i = manageability of risk i
RPN_i = Risk Priority Number of risk i = $RS_i * M_i = P_i * I_i * M_i$

4.2 CONCLUSIONS AND SUMMARY

This section summarizes chapter 4 before we continue with applying the method from this chapter in our case study in Chapter 5. This section ends with the conclusions that we draw from this chapter.

Summary

We started this chapter with the purpose of the method that we propose in the remainder of the chapter. In summary the goal of the method is to provide a structured way in which the value proposition, revenue model and value network of business models can be designed and secured, and compared.

After that, we introduced preconditions en criteria that ideally must all be fulfilled by the proposed method. In section 4.3 we scored the existing methods on those criteria en preconditions to help us in selecting the most promising methods to continue with. From the most suitable methods we created a step by step method that is fully adapted to the situation of NSI. The last part of this chapter summarized the method and provided some practical guidelines on the execution of the method. In short we could say that our method, the RRBS method, consists of 5steps:

1. Define the value proposition making use of the business model canvas
2. Define the earning logic making use of the business model canvas and the three prescribed choices
3. Define the roles making use of the adapted version of NVA
4. Define the risks per role making use of the customized RRBS
5. Quantify and analyze the risks making use of the customized RFMEA

Conclusion

We conclude that the answer to the first sub-question: '*What is a suitable method to map the roles and risk in the network in a structured way?*' would be 'the method that we propose in section 4.3.2 and 4.3.3, the so called Risks and Roles Breakdown Structure'. This method includes elements of the business model canvas, NVA, RBS, and RFMEA and covers all preconditions and elements that are needed. We make use of some principles of RDM as well.

5 EXPLORATIVE CASE STUDY: THE KAREL DOORMAN CASE

In this chapter we perform a case study on the Karel Doorman. In section 2.1.1 we provided a short introduction of the Karel Doorman case. We elaborate on that in section 5.1. We discuss the history and execution of the Karel Doorman Rotterdam project in detail.

In section 5.2 we reconstruct the business model (in terms of value proposition, earning logic and value network) of the Karel Doorman Rotterdam project, followed by a construction of a future Karel Doorman like product. Both the reconstruction and construction are performed together with the Dutch NSI members by applying the method from section 4.3, the RRBS. Remind that after identifying we quantify the risks. In quantifying the risks we distinguish between three situations.

1. The Karel Doorman Rotterdam project (or briefly: KD project). With this we mean the original Karel Doorman project in Rotterdam.
2. The first Karel Doorman like product (or briefly: 1st KD product). With this we refer to the future situation in which a Karel Doorman like product is delivered for the first time. A Karel Doorman like product is a product that replicates the developments that were made in project (ultra light weight construction added to a existing building) according to a Karel Doorman handbook that describes the principles of the original Karel Doorman.
3. The 5th-10th Karel Doorman like product (or briefly: 5th-10th KD product). With this we refer to the future situation in which a Karel Doorman product is delivered when some Karel Doorman like products are already completed. To make this tangible we assume that the 5th-10th Karel Doorman is delivered in this situation.

This section answers the second and third sub question, namely '*What did the network in terms of roles and risk look like during the Karel Doorman project?*' and '*What roles and risk in the network of a future Karel Doorman product are expected?*'

Section 5.3 addresses the fourth sub question: '*What similarities and differences can we find if we compare the roles and risk of the project network and the future product network?*' by comparing the results of the business model reconstruction of the Karel Doorman Rotterdam project and construction of the business model of the future Karel Doorman product.

In section 5.4 we answer the fifth and sixth sub question: '*To what extent can we generalize the results of the Karel Doorman case?*' and '*What are the business consequences of these changes?*'

Chapter 5 ends, as usual, with the conclusions that we draw from the chapter and a summary.

5.1 HISTORY AND EXECUTION OF THE KAREL DOORMAN PROJECT

This section aims to provide in depth understanding of the Karel Doorman Rotterdam project. We obtained this information by interviewing John Kraus, member of NSI and an important person in the history of the Karel Doorman Rotterdam project. Furthermore this section indicates already some risks that occurred during the KD project. We use both these risks and risks that did not occur in our RRBS of the KD project situation.

By the end of the 1990's there was a lack of real estate occupancy in the city center of Rotterdam, the Netherlands (see Figure 5.1). Furthermore the old 'Ter Meulen' building, a shopping mall situated at the famous Lijnbaan, was suffering from low occupancies as well. The municipality of Rotterdam was aiming to bring back the liveliness in the city center by urban densification in terms of housing. The Lijnbaan, however, has an architectural status due to its special characteristics. First of all it was the first pedestrian shopping area in Rotterdam. A pedestrian shopping area was an international novelty that time (1953) and gained much attention worldwide. Furthermore, and most important, the Lijnbaan is an icon of the architecture linked to the reconstruction after the devastating bombardments during World War Two (in Dutch: wederopbouwarchitectuur[8]). This cultural heritance should therefore be protected. Figure 5.2[9] shows the Lijnbaan in Rotterdam. This picture was taken in 1964.

The municipality of Rotterdam nevertheless attempted to house more people in the city center and therefore they updated the land-use planning (in Dutch: bestemmingsplan) for the inner city area. A Danish urban planner assisted the municipality of Rotterdam in developing an urban planning (in Dutch: stedenbouwkundigplan). This planning (Hoogbouwnota 2000) shows where urban densification is possible and up to what height buildings could arise. For the Lijnbaan the maximum height was suddenly extended up to 70 meters.

Important names in the Karel Doorman Rotterdam project

Aad van Tilburg – Architect, soundboard municipality Rotterdam

John Kraus – Structural engineer, owner of D3BN, now NSI member

D3BN – Civil engineering company, sold to DHV (now Royal HaskoningDHV)

Janivo – Owner of 'Ter Meulen' building

Professor Van Luxemburg – Acoustician

Bouwfonds – Property Developer owned by ABN AMRO

Willemsen Minderman – Initial project management

Ibelings van Tilburg Architecten –Architecture company of Aad van Tilburg en Mark Ibelings

Van Wijnen – Main contractor

Fortis – Initial investor

Wilgengroep – Final project management

ASR – Final investor

[8] For more information on wederopbouwarchitectuur, see https://nl.wikipedia.org/wiki/Wederopbouwarchitectuur (in Dutch only)

[9] ANP PHOTO (1964)/Foto: (ANP) gelicenseerd onder de Creative Commons Naamsvermelding-NietCommercieel-GeenAfgeleideWerken 4.0 Licentie

Figure 5.1: Rotterdam indicated on the map of the Netherlands

Figure 5.2: The Lijnbaan in Rotterdam in 1964

In changing the urban planning of the city center of Rotterdam citizens were involved as well. The municipality of Rotterdam invoked several discussion- and sounding boards. One of the members of such a sounding board was Aad van Tilburg, an architect. Aad van Tilburg knew the owner of the 'Ter Meulen' building, Janivo. He proposed to explore the possibilities for this building to be extended at the end of 2000. Janivo, a private real estate investor, was interested in this idea, since the property was suffering from a lack of occupancy. However, he was eager to preserve the monumental building. This was a problem for the architect, since adding storey's to the existing building would cause trouble with the existing foundation of the building.

To check whether this problem could be overcome Aad van Tilburg consulted John Kraus, a structural engineer, with whom he was familiar from former projects. John Kraus (co owner of D3BN, a civil engineering company) performed a feasibility study. John Kraus also involved Professor R. van Luxemburg, an acoustician. Together they gained experience of building on an existing construction during the earlier NEMO project. NEMO is a museum build upon the foundations of a tunnel, the IJ-tunnel. Figure 5.3[10] shows the NEMO museum in Amsterdam constructed upon existing infrastructure.

The result of the feasibility study was the idea of an ultra-lightweight construction made of steel together with wood. By making use of two concrete stability cores at the backside of the building it would then be possible to add 16 layers to the existing building. Aad van Tilburg went back to the owner of the building, Janivo, who was very pleased with this idea. Those 16 layers can be used for housing, which would lead to a stream of revenues and a more attractive business climate for retailers in the substructure.

[10] Photo: Erik Zachte (2012)- *Renzo Piano's Science Museum NEMO in Amsterdam, built above IJ-tunnel*

Figure 5.3: The NEMO museum upon the IJ-tunnel

Janivo did not consider itself as a property developer and therefore hired Bouwfonds, which is a property developer that conducted more projects at the Lijnbaan. The financial risks of this development process remained at property owner, Janivo. Bouwfonds was a Dutch local government mortgage and building development organization, but just had been bought by ABN AMRO, a large Dutch banking institution (Wikipedia, 2015). Bouwfonds was enthusiastic about the idea and their calculations showed positive results. Bouwfonds placed out the project to Willemsen Minderman. John Kraus and Aad van Tilburg were familiar with Willemsen Minderman due to other projects they were involved in, for example the Solaris building.

John Kraus, who had sold D3BN to International engineering consultant DHV and was therefore working at DHV at that time, and Ibelings Van Tilburg Architecten (the architecture company of Aad van Tilburg and its companion Mark Ibelings) started the final design of the project.

Bouwfonds contracted Van Wijnen as main contractor to build the project to a fixed price. Van Wijnen sub contracted smaller parties for the execution of the building process. The building process first started in 2006. The project management was done by Willemsen Minderman at that time.

Janivo, the owner of the substructure, was not prepared to finance the 16-storey apartment block. Therefore, Fortis, an investor, invested in the superstructure, so that they could rent out or sell the apartments later on. Fortis took over the superstructure from Janivo, including the risks, and therefore had a say in the exact execution of the houses. Bouwfonds remained developer for Fortis as well. Fortis was a bit pessimistic about quality of the apartments in the current design, so they increased the design demands, since the selling prices of the apartments must be higher now that another sale transaction had taken place. All parties still have to make money out of these sale transactions after all. Therefore design changes were made. Moreover, the original planned soundproofing was updated such that it would not only meet the standards at that time, but also would cover for extra decibels.

Van Wijnen outsourced the risk on the steel construction to a co-contractor, the supplier of the steel construction. The original plan of the structural engineers was to test the

construction on vibrations during a period of eight weeks while the construction process was on hold. However, in an earlier stage of the construction process unexpected and unwanted movements in the construction were observed by the structural engineers, so adjustments in the steel construction design were necessary.

During the construction process some people at the developer side were involved in a real estate fraud scandal (in Dutch: het vastgoedfraudeschandaal). The construction process was grinding to a halt in 2008. Although this gave a bad impression to the outside world, it did give the construction engineers the time to adjust the steel construction and to test the construction (steel and wood). Unfortunately, the inactivity of the building process went way beyond the time needed for the testing and adjusting. The reason for this is twofold. On one hand the real estate fraud scandal slowed down the process, on the other hand, Fortis encountered severe problems too and was nationalized by the Dutch government. Fortis was split up and some parts became part of ASR. ASR therefore took over the investment. The building process was restarted in 2010.

The project was finished under supervision of De Wilgengroep that took over the role of Willemsen Minderman. De Wilgengroep sold part of the apartments and rented out the other part on behalf of ASR. After completion of the Karel Doorman, as the new building is called, in 2012 the retail area in the original Ter Meulen building is rented out to a very high occupancy and is still owned by Janivo. The construction won several prizes for its innovative design and all the apartments are sold or rented out. In the end the result of project, the Karel Doorman building in Rotterdam, turned out to be very successful, although the path to get there was not always a smooth one. Figure 5.4 shows a timeline that includes the most important milestones of the project.

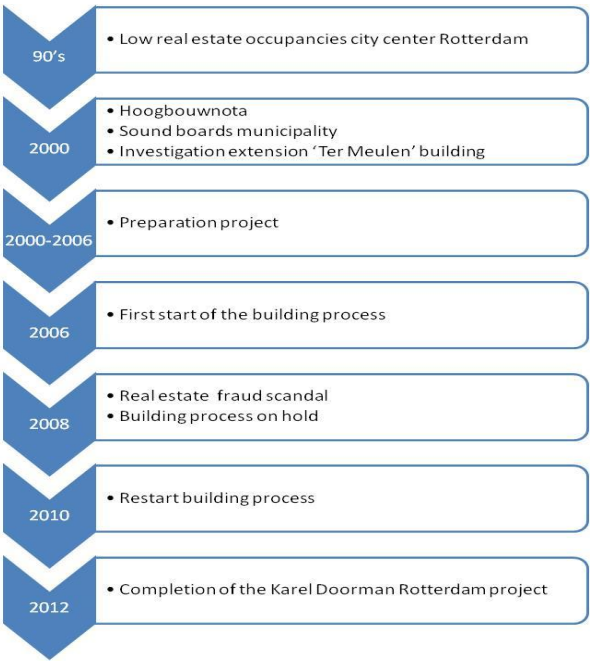


Figure 5.4: Important milestones in the Karel Doorman Rotterdam project

5.2 (RE-)CONSTRUCTING THE BUSINESS MODELS

In this section we reconstruct the business model of the Karel Doorman Rotterdam project in sub section 5.2.1. In sub section 5.2.2 we continue with predicting the business model for a Karel Doorman product. To (re)construct these business models we use the RRBS, the method that we introduced in section 4.1. We organized a session with all the Dutch NSI members, including John Kraus, who was heavily involved in the Karel Doorman project, to execute this method, see section 5.1. The other members include a business unit director, a senior consultant, and a senior business developer. All members are experienced in projects like the Karel Doorman project, and furthermore in thinking about the effects of turning projects into products.

5.2.1 MAPPING THE BUSINESS MODEL OF THE KAREL DOORMAN PROJECT

During the method execution session, we first introduced the rules of engagement. One of the NSI members volunteered to take notes of the session, which gave the session leader the opportunity to focus on the process only.

Value proposition

We started the session with the determination of the value proposition. The following questions of the Business Model Canvas served as a guideline:

- What value do we deliver to the customer?
  We provide the customer with an innovative, ultra lightweight[11] construction that adds a 16-storey apartment complex to an existing building.
- Which one of our customer's problems are we helping to solve?
  The problem to add as much height as possible to an existing building that should be preserved.
- Which customer needs are we satisfying?
  More revenue streams and liveliness close to the retail stores.
- What bundles of products and services are we offering to each Customer Segment?
  We offer a construction design with innovative techniques and innovative use of materials. The design provides high quality living environment due to for example high standards of soundproofing.

Earning logic

The earning logic for the Karel Doorman project was the traditional earning logic for Royal HaskoningDHV, namely: Amount of hours worked * hourly rate.

[11] The construction of the Karel Doorman Rotterdam weights only 20% of a similar construction build in a traditional way where concrete is used instead of steel and wood.

Roles in the value network

We started this part of the session by defining the network boundaries. We consider the network to be formed by every party that contributes value to the end product (the Karel Doorman building) until the moment that all apartments are sold or rented out. We decided to go 1-level deep, which means that if for example the main contractor involves sub contractors, that we only consider the main constructor as a role.

From the description of the project we derived the corresponding roles. The roles in the value network that we defined are as follows (where necessary we explained the role in italics):

1. Policy maker
   The policy maker decides upon the long term vision of urban planning and enables initiatives.
2. Supplier of planning permission (in Dutch: vergunningsverlener)
   The supplier of the planning per permission gives permits on the building plans, changes of use, etcetera.
3. Owner or tenant substructure
   The owner and/or tenant of the substructure agree to use the foundation of its building to build upon.
4. Designer of the appearance of the building (architect)
5. Designer of the construction (engineer)
6. Other advisors, such as installation advisors, steel construction advisors
7. Project developer (including project management)
8. Financer (for example investment banks)
9. Main contractor
10. Owner of the superstructure
11. Land owner

Linking roles and risks in the value network

Now that we know which roles are present in the value network of the Karel Doorman project, we can fill out these roles in the RRBS as we designed it for NSI. We decided to structure the brainstorm session by first brainstorming on all financial risks and assign those to one (or more) of the roles. We continued with the input risks, etcetera, until we reached the other risks type. Table 5.1 shows the results of RRBS. We underlined the role of NSI (or Royal HaskoningDHV). For greater legibility we removed the level 0 column (all risks in the value network, see Appendix A).

On the other hand we included a risk code which is built as follows: *abbreviation role-first letter of risk type, index number.* The abbreviations of the roles are provided between brackets in the Level 1 column. The index number indicates a specific risk in case of multiple risks per role-type combination, and is based on the order in which the risks are provided in

the table. PM-R1 for example means Policy Maker- Reputation risk 1. We use these codes in the analysis of the results, since including the whole risk description in tables and figures would be impossible. We provide an overview of the risk codes in Appendix C.

Table 5.1: RRBS for the Karel Doorman Rotterdam project

Level 1 (roles)	Level 2 (risk types)	Level 3 (relevant risks)	Risk code
Policy maker (PM)	Financial		
	Input		
	Reputation	Failure of the project can lead to image damage, which can ultimately result in (forced) resignation of the alderman (in Dutch: wethouder).	PM-R1
	Legislation & Regulation		
	Technical		
	Other		
Supplier of planning permission (SP)	Financial		
	Input		
	Reputation		
	Legislation & Regulation	Council of State decides otherwise on the planning permission. Ultimate no-go for the project.	SP-L1
	Technical		
	Other		
Owner/tenant substructure (OSB)	Financial	The risk of not having the financial benefits as expected beforehand (no extra revenues).	OSB-F1
	Input		
	Reputation		
	Legislation & Regulation		
	Technical	Damage to substructure.	OSB-T1
	Other		
Designer of the appearance (DA)	Financial	Having done unpaid pre work (investment costs) when the project is not executed in the end.	DA-F1
	Input	Lack of information or wrong information on end-user needs, whishes, and requirements.	DA-I1
	Reputation	Negative public opinion on the appearance of the building.	DA-R1
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	DA-O1
Designer of the construction (DC)	Financial	Having done unpaid pre work (investment costs) when the project is not executed in the end. Longer run time than expected causes deferred revenues which can lead to cash flow problems.	DC-F1 DC-F2
	Input	Wrong information on the foundation and structural design of the substructure, which could	DC-I1

		lead to construction errors.	
	Reputation	Mistakes in the construction could lead to image damage (the exposure to this risk depends heavily on existing image).	DC-R1
	Legislation & Regulation	Claims of the project developer due to poor performance. Absence of legislation, since unproven technologies are used.	DC-L1 DC-L2
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	DC-01
Other designers / Advisors (OA)	Financial		
	Input		
	Reputation		
	Legislation & Regulation	Absence of legislation, since unproven technologies are used. This can lead to risks that are uninsurable. Claims of the project developer due to poor performance.	OA-L1 OA-L2
	Technical	The risk of not being able to live up to the guarantees given.	OA-T1
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	OA-O1
Project developer (PjD)	Financial	Overrun of investment costs (in Dutch: stichtingskosten[12]). Loosing pre financing because of a no go for the project.	PjD-F1 PjD-F2
	Input	Wrong or lack of information needed for the business case, such as information on market prices.	PjD-I1
	Reputation	In case of failure of the project it might be hard for the project developer to get financing in later projects.	PjD-R1
	Legislation & Regulation	Not getting the planning permission. Negative outcomes of an archaeological research. Negative impact of the Monuments Act. Changes in laws and regulation during the project execution. Claim from substructure owner in case of damage.	PjD-L1 PjD-L2 PjD-L3 PjD-L4 PjD-L5
	Technical	Malfunctioning of the final construction	PjD-T1
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PjD-O1
Financer (F)	Financial	Bankruptcy of project developer (not getting investment back).	F-F1
	Input	Lack of information on financial health of project developer.	F-I1

[12] 'Stichtingskosten' include all costs involved in founding a construction project, for example: purchase of land, construction costs, consultancy fees, other fees, interest costs, and unforeseen expenses. Translated from: https://nl.wikipedia.org/wiki/Stichtingskosten

	Reputation		
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	F-O1
Main contractor (MC)	Financial	Exceeding budgeted building costs (fixed price thus exceeding costs means less profit, or even a loss).	MC-F1
	Input	Troubles with deliveries of building materials (late, incomplete, inferior quality). Mistakes in or misinterpretation of plans (drawings).	MC-I1 MC-I2
	Reputation	Causing nuisance in the eyes of the public opinion.	MC-R1
	Legislation & Regulation	Revoked licenses (noise permits, exit permits, etcetera)	MC-L1
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	MC-O1
Owner of the superstructure (OSP)	Financial	Vacancy risk (collapse of the housing market)	OSP-F1
	Input		
	Reputation		
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	OSP-O1
Land owner (LO)	Financial	Opportunity costs[13]	LO-F1
	Input		
	Reputation		
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	LO-O1

[13] Opportunity costs are 'the cost of an alternative that must be forgone in order to pursue a certain action. Put another way, the benefits you could have received by taking an alternative action.' (Investopedia, n.d.) In this case it means that a land owner can lend out or sell the land only once. If during the project another alternative that yields more passes by the land owner does not have the opportunity any more to choose the alternative with a higher yield.

5.2.2 MAPPING THE BUSINESS MODEL OF A FUTURE KAREL DOORMAN PRODUCT

After mapping the relevant elements of the business model of the Karel Doorman Rotterdam project, we continued with constructing the same elements of the future business model of a Karel Doorman like product. We have chosen for the value proposition and revenue logic that we expected to be the most radical for NSI. Our choice for this value proposition and earning logic does not mean that we advise or discourage any of the possible earning logics and value propositions.

Value proposition

We started the session with the determination of the value proposition. The following questions of the Business Model Canvas served as a guideline:

- What value do we deliver to the customer?
  We provide the customer with a proven solution that adds space to an existing building without demolishing the existing building. The extra space is provided by making use of an ultra lightweight construction and proven high quality user environment in terms of soundproofing, acoustics, fire safety, etcetera and is designed according to the Karel Doorman handbook. The prefab solution limits construction time and nuisance to surrounding area.
- Which one of our customer's problems are we helping to solve?
  The problem to add as much height as possible to an existing building that cannot be demolished. The problem of not having building ground available.
- Which customer needs are we satisfying?
  The need for urban densification. The need to focus on its core business. The need for clarity of the outcomes beforehand.
- What bundles of products and services are we offering to each Customer Segment?
  We offer fully designed and proven product (an x-storey building upon the existing building), including project management.

Earning logic

Since we are looking into the future we have to determine an earning logic to give context to our search for roles and risks. We therefore assume that NSI will apply the earning logic: 'a product with performance guarantees', see section 1.2.4, on future Karel Doorman products. The price of the product includes the services. The profit for NSI is the price of the product-costs for the sales network – development costs – proposal costs – costs for working capital.

In reality NSI has not taken a decision on the earning logic for Karel Doorman products. Furthermore this choice could be heavily depending on the customer and its location.

Roles in the value network

We started this part of the session by rehearsing the network boundaries. We continued with thinking about the steps/activities that will be taken in realizing a Karel Doorman product. From these steps/activities we deduced the roles in the value network. The roles in the value network that we defined are as follows (where necessary we explained the role in italics):

1. Policy maker
   The policy maker decides upon the long term vision of urban planning and enables initiatives.
2. Supplier of planning permission (in Dutch: vergunningsverlener)
   The supplier of the planning per permission gives permits on the building plans, changes of use, etcetera.
3. Owner or tenant substructure
   The owner and/or tenant of the substructure agree(s) to use the foundation of its building to build upon.
4. Supplier of the Karel Doorman product (including project management)
5. Project manager with local market knowledge (hired by the supplier against a fee).
6. Financer (for example investment banks)
7. Main contractor
8. Owner of the superstructure
9. Land owner

Linking roles and risks in the value network

Now that we know which roles are present in the value network of a future Karel Doorman product, we can fill out these roles in the RRBS as we designed it for NSI. We again decided to structure the brainstorm session by first brainstorming on all financial risks and assign those to one (or more) of the roles. We continued with the input risks, etcetera, until we reached the 'other risks' risk type.

Table 5.2 shows the RRBS for a Karel Doorman product. We underlined the role of NSI (or Royal HaskoningDHV).*An important remark is that delivering a product like the Karel Doorman product is still a construction project to other roles, than the supplier of the Karel Doorman product.* In Table 5.2 we also provide a risk code for every risk. The way this risk code is obtained is the same as in Table 5.1. However, all codes in Table 5.2 start with PD which indicates that this risk is present within the ProDuct Karel Doorman. For the 5^{th}-10^{th} Karel Doorman like product we use the same codes, which however start with 'PD5' instead of PD. For legibility reasons we did not include those codes in Table 5.2.

In risk quantifying we use the same roles and risks for both the 1^{st} KD product and 5-10^{th} KD product. We provide the abbreviations per role between brackets in the level 1 column.

Table 5.2: RRBS for a Karel Doorman like product (1st and 5th-10th)

Level 1 (roles)	Level 2 (risk types)	Level 3 (relevant risks)	Risk code for 1st product
Policy maker (PM)	Financial		
	Input		
	Reputation	Failure of the realization of the Karel Doorman product can lead to image damage, which can ultimately result in (forced) resignation of the alderman.	PD-PM-R1
	Legislation & Regulation		
	Technical		
	Other		
Supplier of planning permission (SP)	Financial		PD-SKD-F1
	Input		PD-SKD-F2
	Reputation		PD-SKD-F3
	Legislation & Regulation	Council of State decides otherwise on the planning permission.	PD-SP-L1 SKD-F4
	Technical		PD-SKD-I1
	Other		PD-SKD-I2
Owner/tenant substructure (OSB)	Financial	The risk of not having the financial benefits as expected beforehand (no extra revenues).	PD-OSB-F1
	Input		
	Reputation		
	Legislation & Regulation		
	Technical	Damage to the substructure.	PD-OSB-T1
	Other		
Supplier of the Karel Doorman product (SKD)	Financial	Having done unpaid pre work (investment costs) when the product is not realized in the end. Longer run time than expected causes deferred revenues which can lead to cash flow problems. Overrun of investment costs (in Dutch: stichtingskosten). Loosing pre financing in case of a no go for realization of the product.	PD-SKD-F1 PD-SKD-F2 PD-SKD-F3 PD-SKD-F4
	Input	Lack of information or wrong information on end-user needs, whishes, and requirements. Wrong information on the foundation and structural design of the substructure, which could lead to construction errors. Wrong or lack of information needed for the business case, such as information on market prices. Wrong or lack of information from project manager with local market knowledge.	PD-SKD-I1 PD-SKD-I2 PD-SKD-I3 PD-SKD-I4
	Reputation	In case of failure of the project it might be hard for the product supplier to get financing in later executions of the product. Negative public opinion on the outlook of the building. Mistakes in the construction could lead to image damage (the exposure to this risk depends heavily on existing image). Claims of the project developer due to poor	PD-SKD-R1 PD-SKD-R2 PD-SKD-R3

		performance.	PD-SKD-R4
	Legislation & Regulation	Absence of legislation, since unproven technologies are used. This can lead to risks that are uninsurable.	PD-SKD-L1
		Not getting the planning permission.	PD-SKD-L2
		Negative outcomes of an archaeological research.	PD-SKD-L3
		Negative impact of the Monuments Act.	PD-SKD-L4
		Changes in laws and regulation during the product realization.	PD-SKD-L5
		Claim of substructure owner in case of damage.	PD-SKD-L6
	Technical	The risk of not being able to live up to the guarantees given.	PD-SKD-T1
		Malfunctioning of the final construction.	PD-SKD-T2
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-SKD-O1
		Lack of expertise present in company to fulfill new role.	PD-SKD-O2
		Lack of capacity to develop several Karel Doorman products in parallel due to large role.	PD-SKD-O3
Project manager with local market knowledge (PMK)	Financial	Underestimation of the costs (less profit since the project manager agreed upon a fixed fee).	PD-PMK-F1
	Input		
	Reputation	Not delivering proper local market information can lead to missing out on future orders.	PD-PMK-R1
	Legislation & Regulation	Claim by the 'supplier of the product' for not delivering proper local market knowledge.	PD-PMK-L1
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-PMK-O1
Financer (F)	Financial	Bankruptcy of supplier of the Karel Doorman product (not getting investment back).	PD-F-F1
	Input	Lack of information on financial health of supplier of the Karel Doorman product.	PD-F-I1
	Reputation		
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-F-O1
Main contractor (MC)	Financial	Exceeding budgeted building costs (fixed price thus exceeding costs means less profit, or even a loss).	PD-MC-F1
	Input	Troubles with deliveries of building materials (late, incomplete, inferior quality).	PD-MC-I1
		Mistakes in or misinterpretation of plans (drawings).	PD-MC-I2
	Reputation	Causing nuisance in the eyes of the public opinion.	PD-MC-R1
	Legislation & Regulation	Revoked licenses (noise permits, exit permits, etcetera)	PD-MC-L1
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-MC-O1
Owner of the superstructure (OSP)	Financial	Vacancy risk (collapse of the housing market)	PD-OSP-F1
	Input		
	Reputation		
	Legislation &		

	Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-OSP-O1
Land owner (LO)	Financial	Opportunity costs[7]	PD-LO-F1
	Input		
	Reputation		
	Legislation & Regulation		
	Technical		
	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-LO-O1

After this session we worked out the minutes. The minutes are shared en discussed with attendees. Based on this second, short discussion of the first results, we made some adjustments (which are already included in Table 5.1 and Table 5.2).

5.2.3 QUANTIFYING THE RISKS

Now that we identified the risks, we move on with quantifying the risks. We have chosen to send an excel file with these risks to four NSI members to score the risks individually on *probability*, *impact*, and *manageability*. These four members were chosen due to their experience with either the Karel Doorman project, or risk assessment, or equivalent project- and product types. We then took the average of all individual scores and calculate the risk score and risk priority number per risk.

We asked the four NSI experts to quantify the risks for the Karel Doorman Rotterdam project, the risks for a future Karel Doorman like product as if it were the first Karel Doorman like product that is delivered, and the risks for a future Karel Doorman like product as if it were the fifth to tenth Karel Doorman like product that is delivered. For the latter two, we both use the risks for the future Karel Doorman like product. We, however, distinguish between the two, since we expect that the risks become smaller when the product is replicated. This repeatability is one of the core arguments for the Business Line buildings to investigate the opportunities in delivering products, and thus the foundation of NSI.

In Table 5.3: Quantified risks for the Karel Doorman projectTable 5.3, Table 5.4 and Table 5.5, we included the averages of the four individual scores. We included the individual scores in Appendix A. The risk codes are the same for the 5th-10th Karel Doorman product as for the 1st Karel Doorman product (see Table 5.2), with the exception that the codes for the 1st Karel Doorman product start with ‘PD’, whereas the risk codes for the 5th-10th Karel Doorman product start with ‘PD5’. We included the risk codes for the 5th-10th Karel Doorman product in Appendix C.

Table 5.3: Quantified risks for the Karel Doorman project, based on the risks in Table 5.1

Risk code	Probability	Impact	Manageability	Risk Score	Risk priority number
PM-R1	1.8	3.5	3.3	6.1	19.9
SP-L1	1.5	4.8	3.0	7.1	21.4
OSB-F1	3.3	3.8	2.8	12.2	33.5
OSB-T1	2.0	3.8	3.3	7.5	24.4
DA-F1	3.8	2.0	2.8	7.5	20.6
DA-I1	3.8	3.8	3.0	14.1	42.2
DA-R1	2.8	2.0	3.3	5.5	17.9
DA-O1	3.0	2.8	2.5	8.3	20.6
DC-F1	3.5	2.0	2.8	7.0	19.3
DC-F2	3.5	3.8	3.3	13.1	42.7
DC-I1	3.0	3.8	3.3	11.3	36.6
DC-R1	2.0	2.8	1.8	5.5	9.6
DC-L1	2.5	3.3	2.0	8.1	16.3
DC-L2	3.3	2.5	3.0	8.1	24.4
DC-O1	2.8	2.8	2.5	7.6	18.9
OA-L1	2.0	2.0	3.0	4.0	12.0
OA-L2	2.0	3.3	2.0	6.5	13.0
OA-T1	2.0	3.3	1.8	6.5	11.4
OA-O1	2.8	2.8	2.5	7.6	18.9
PjD-F1	3.5	4.3	2.8	14.9	40.9
PjD-F2	3.5	3.0	2.5	10.5	26.3
PjD-I1	2.3	3.8	2.8	8.4	23.2
PjD-R1	1.8	2.8	2.0	4.8	9.6
PjD-L1	2.5	3.0	3.3	7.5	24.4
PjD-L2	1.3	2.3	4.3	2.8	12.0
PjD-L3	1.5	1.8	4.0	2.6	10.5
PjD-L4	1.5	3.3	3.5	4.9	17.1
PjD-L5	1.8	3.3	2.8	5.7	15.6
PjD-T1	1.5	4.8	2.5	7.1	17.8
PjD-O1	3.0	2.8	2.3	8.3	18.6
F-F1	3.0	4.5	2.8	13.5	37.1
F-I1	1.8	2.8	1.8	4.8	8.4
F-O1	3.0	2.8	3.3	8.3	26.8
MC-F1	2.8	3.8	2.0	10.3	20.6
MC-I1	2.3	3.3	2.3	7.3	16.5
MC-I2	2.0	3.5	2.3	7.0	15.8
MC-R1	1.8	2.0	3.0	3.5	10.5
MC-L1	2.5	2.5	1.5	6.3	9.4
MC-O1	3.3	2.8	2.5	8.9	22.3
OSP-F1	2.3	4.5	4.0	10.1	40.5
OSP-O1	3.0	2.8	2.5	8.3	20.6
LO-F1	2.0	2.3	3.3	4.5	14.6
LO-O1	2.8	2.8	3.0	7.6	22.7

Table 5.4: Quantifying risks of a first Karel Doorman like product, based on the risks in Table 5.2

Risk code	Probability	Impact	Manageability	Risk score	Risk priority number
PD-PM-R1	1.8	3.3	3.0	5.7	17.1
PD-SP-L1	1.8	4.0	2.8	7.0	19.3
PD-OSB-F1	3.0	3.8	2.8	11.3	30.9
PD-OSB-T1	2.0	3.3	3.3	6.5	21.1
PD-SKD-F1	3.8	2.0	2.8	7.5	20.6
PD-SKD-F2	3.3	3.0	2.8	9.8	26.8
PD-SKD-F3	3.3	3.5	2.3	11.4	25.6
PD-SKD-F4	3.5	3.3	2.8	11.4	31.3
PD-SKD-I1	3.0	3.8	3.5	11.3	39.4
PD-SKD-I2	2.5	3.0	2.5	7.5	18.8
PD-SKD-I3	2.8	3.8	3.3	10.3	33.5
PD-SKD-I4	3.0	3.5	2.8	10.5	28.9
PD-SKD-R1	1.8	2.5	2.8	4.4	12.0
PD-SKD-R2	3.0	3.5	3.0	10.5	31.5
PD-SKD-R3	1.5	1.8	3.5	2.6	9.2
PD-SKD-R4	2.3	2.5	2.5	5.6	14.1
PD-SKD-L1	3.0	3.3	2.0	9.8	19.5
PD-SKD-L2	1.5	2.8	4.3	4.1	17.5
PD-SKD-L3	1.8	2.8	3.5	4.8	16.8
PD-SKD-L4	1.5	2.8	3.5	4.1	14.4
PD-SKD-L5	1.8	3.3	2.0	5.7	11.4
PD-SKD-L6	1.8	2.0	2.8	3.5	9.6
PD-SKD-T1	2.8	3.5	1.8	9.6	16.8
PD-SKD-T2	1.5	4.3	1.8	6.4	11.2
PD-SKD-O1	3.3	3.5	1.5	11.4	17.1
PD-SKD-O2	2.3	3.3	1.5	7.3	11.0
PD-SKD-O3	3.0	3.3	2.3	9.8	21.9
PD-PMK-F1	2.8	3.5	2.5	9.6	24.1
PD-PMK-R1	2.0	2.8	2.3	5.5	12.4
PD-PMK-L1	1.8	3.5	2.3	6.1	13.8
PD-PMK-O1	2.8	2.8	2.8	7.6	20.8
PD-F-F1	1.3	4.5	2.3	5.6	12.7
PD-F-I1	2.0	2.0	2.0	4.0	8.0
PD-F-O1	3.0	3.0	3.0	9.0	27.0
PD-MC-F1	2.8	4.0	2.5	11.0	27.5
PD-MC-I1	2.0	3.3	2.3	6.5	14.6
PD-MC-I2	1.8	3.5	2.3	6.1	13.8
PD-MC-R1	2.3	2.0	3.0	4.5	13.5
PD-MC-L1	2.0	2.5	2.0	5.0	10.0
PD-MC-O1	3.3	2.3	2.3	7.3	16.5
PD-OSP-F1	2.0	4.0	3.5	8.0	28.0
PD-OSP-O1	2.8	2.8	2.5	7.6	18.9
PD-LO-F1	2.0	2.0	3.3	4.0	13.0
PD-LO-O1	2.5	2.8	3.0	6.9	20.6

Table 5.5: Quantified risks of a fifth-tenth Karel Doorman like product, based on the risks in Table 5.2.

Risk code	Probability	Impact	Manageability	Risk score	Risk priority number
PD5-PM-R1	1.5	3.3	3.0	4.9	14.6
PD5-SP-L1	1.8	4.0	2.8	7.0	19.3
PD5-OSB-F1	2.5	3.8	2.8	9.4	25.8
PD5-OSB-T1	2.0	3.3	3.3	6.5	21.1
PD5-SKD-F1	3.3	1.8	2.8	5.7	15.6
PD5-SKD-F2	2.3	3.0	2.5	6.8	16.9
PD5-SKD-F3	2.0	3.5	2.3	7.0	15.8
PD5-SKD-F4	3.0	3.0	2.8	9.0	24.8
PD5-SKD-I1	2.8	3.8	3.5	10.3	36.1
PD5-SKD-I2	2.3	3.0	2.5	6.8	16.9
PD5-SKD-I3	2.5	3.5	3.3	8.8	28.4
PD5-SKD-I4	2.5	3.5	2.8	8.8	24.1
PD5-SKD-R1	1.8	2.5	2.8	4.4	12.0
PD5-SKD-R2	2.8	3.3	3.0	8.9	26.8
PD5-SKD-R3	1.5	1.8	3.5	2.6	9.2
PD5-SKD-R4	1.8	2.5	2.5	4.4	10.9
PD5-SKD-L1	2.5	3.0	2.0	7.5	15.0
PD5-SKD-L2	1.5	2.8	4.3	4.1	17.5
PD5-SKD-L3	1.8	2.8	3.5	4.8	16.8
PD5-SKD-L4	1.5	2.8	3.5	4.1	14.4
PD5-SKD-L5	1.8	3.3	2.0	5.7	11.4
PD5-SKD-L6	1.5	2.0	2.8	3.0	8.3
PD5-SKD-T1	2.0	3.5	1.8	7.0	12.3
PD5-SKD-T2	1.5	4.3	1.8	6.4	11.2
PD5-SKD-O1	2.0	3.3	1.5	6.5	9.8
PD5-SKD-O2	2.0	3.3	1.8	6.5	11.4
PD5-SKD-O3	2.0	3.0	2.3	6.0	13.5
PD5-PMK-F1	2.0	2.8	2.5	5.5	13.8
PD5-PMK-R1	2.0	2.8	2.3	5.5	12.4
PD5-PMK-L1	1.8	3.5	2.3	6.1	13.8
PD5-PMK-O1	2.3	2.8	2.8	6.2	17.0
PD5-F-F1	1.3	4.5	2.3	5.6	12.7
PD5-F-I1	1.8	2.8	2.0	4.8	9.6
PD5-F-O1	2.5	3.0	3.0	7.5	22.5
PD5-MC-F1	2.5	4.0	2.5	10.0	25.0
PD5-MC-I1	1.8	3.3	2.3	5.7	12.8
PD5-MC-I2	1.5	3.5	2.3	5.3	11.8
PD5-MC-R1	2.3	2.0	3.0	4.5	13.5
PD5-MC-L1	2.0	2.5	2.0	5.0	10.0
PD5-MC-O1	2.5	2.8	2.5	6.9	17.2
PD5-OSP-F1	2.0	3.0	3.5	6.0	21.0
PD5-OSP-O1	2.5	2.8	3.3	6.9	22.3
PD5-LO-F1	2.0	2.0	3.3	4.0	13.0
PD5-LO-O1	2.3	2.8	3.0	6.2	18.6

An important remark is that for the Karel Doorman project Rotterdam it is known which risks did or did not occur. If a risk has occurred it not directly means that the probability of occurring scores a 5, since it could have still been a very small change which came out during that project due to very rare circumstances. Consequently, it also does not mean that all the risk that did not occur should score a 1 for probability. We asked the experts to keep this in mind when scoring the risks of the Karel Doorman Rotterdam project on probability.

For the risk that did occur the impact and manageability are however known, and therefore we assume that the scores on these dimensions are rather accurate. For risks that did not occur, these dimensions are still heavenly depending on experts expectations.

5.3 ANALYSIS OF THE VALUE NETWORKS IN TERMS OF ROLES AND RISKS

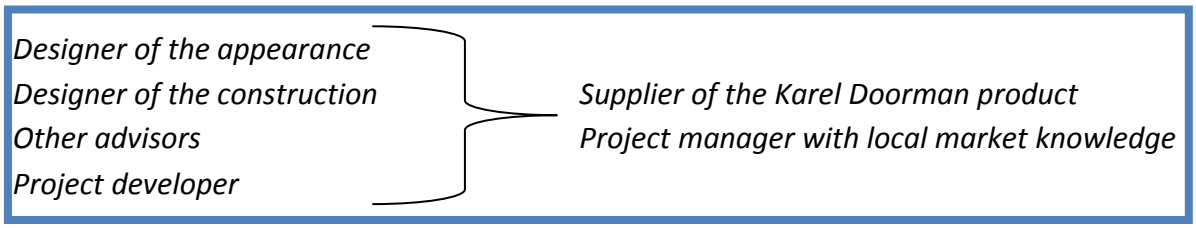
In this section we analyze and compare the results of the two value networks, Karel Doorman as a project and Karel Doorman as a product. For the latter we also distinguish between the first Karel Doorman product and the fifth-tenth Karel Doorman product. We start our analysis with an analysis of the value network in terms of roles in section 5.3.1. After that we continue our analysis with the value network in terms of risks in section 5.3.2.

5.3.1 ANALYSIS VALUE NETWORK IN TERMS OF ROLES

During the KD project the value network consisted of eleven roles that needed to be filled in. If the Karel Doorman is turned into a product only nine roles are needed. *The supplier of the Karel Doorman product* integrated the roles of *the designer of the appearance of the building (architect)*, *the designer of the construction (engineer)*, *the other advisors*, such as installation advisors and steel construction advisors, and a *large part of the role of the project developer*.

A *small part of the role of project developer* still remains a separate role. This is the *project manager with local market knowledge* role. This role adds value by providing local market knowledge which is very important input for the business case of the other parties, especially *the supplier of the Karel Doorman product*.

In short the following happened:



We could say that by turning the project in to a product the value for the client is delivered by a more compact value network. In terms of benefits that means that the total value expressed in revenues has to be divided by less parties.

5.3.2 ANALYSIS VALUE NETWORK IN TERMS OF RISKS

In this section we analysis the similarities and differences between the risks in the KD Rotterdam project, the first KD product, and the fifth-tenth KD product situation.

Aggregated risks per role and total risk

Table 5.6 shows the aggregated risk scores per role per situation (project, first product, fifth-tenth product). The last row sums up the risk scores and RPN of all roles that are present in that situation.

Table 5.6: Aggregated risk score and aggregated RPN per role per situation and total risk score per situation

Role	Risk score KD Rotterdam project	RPN KD Rotterdam project	Risk score 1st KD product	RPN 1st KD product	Risk score 5th-10th KD product	RPN 5th-10th KD product
Policy maker	6	20	6	17	5	15
Supplier of permission	7	21	7	19	7	19
Owner substructure	20	58	18	52	16	47
Designer of the appearance (architect)	35	101				
Designer of the construction	61	168				
Other advisors	25	55				
Project developer	78	216				
Supplier of the KD product			179	459	145	379
Project manager with local market knowledge			29	71	23	57
Financer	27	72	19	48	18	45
Main contractor	43	95	40	96	37	90
Owner superstructure	18	61	16	47	13	43
Land owner	12	37	11	34	10	32
Project/product Total	331	905	324	842	274	727

Remind that:
RS = Risk Score= Probability * Impact
Aggregated Risk Score for role j = sum of Risk scores of all risks i that are carried by role j
RPN = Risk Priority Number = Risk score * manageability = Probability * Impact * Manageability
Aggregated RPN for role j= sum of all RPN scores of all risks i that are carried by role j

From Table 5.6 we can draw several conclusions. First of all we conclude that the total Risk Score stays more or less the same if we compare the project situation with the 1st product situation (from 331, to 324). However if we compare the total Risk Score of the KD Rotterdam project situation with the 5th-10th KD product situation we see a clear decrease in the risk score (from 331 to 274). This means that the scalability of a product reduces the risks in the value network.

The second conclusion is that the Risk priority number (when manageability is thus included) decreases from 905 in the project situation, to 842 for the 1st KD like product, and even further to 727 in the 5th-10th KD like product situation.

We furthermore conclude that the highest aggregated risk (in terms of both risk score and RPN) is carried by *the project developer* in the project situation. For both product situations the highest amount of risk is carried by *the supplier of the Karel Doorman*. This makes sense since a large part of the project development role is taken over by *the supplier of the Karel Doorman in product situations*. This supplier role furthermore integrates three roles of the project situation as we explained in the former sub section. This leads to a large, leading role in the value network. Another consequence is a more compact value network.

We summarized the consequences in terms of aggregated risk of this role integration in Table 5.7. From this Table we conclude that the integration of 4 roles in the project situation to 2 roles in the product situations leads to a small increase in total risk for those roles in terms of Risk score and a small decrease in RPN in the 1st KD product situation. That means that the risk became more manageable for the 2 roles instead of the 4 roles. However in the 5th-10th product situation both Risk score and RPN decreased significantly compared to the project situation.

Table 5.7: Consequences of role integration in terms of aggregated risk

	4 roles KD Rotterdam project	2 roles 1st KD product	2 roles 5th-10th KD product
Aggregated Risk score	198	208	168
Aggregated RPN	540	530	436

From Table 5.6 we could also conclude that *the financer* has significant lower aggregated risks in terms of both Risk score and RPN in the product situations compared to the project situation. The other roles that remain the same in the KD like product situations have slightly decreased aggregated risks as well.

If we compare the aggregated risks per role of the 1st product situation with the 5th-10th product situation we see that especially th*e supplier of the Karel Doorman* and *the project manager with local market knowledge* benefit significantly in terms of risks from replicating the product. All the other roles slightly benefit from this replication.

Individual risks

Besides from the aggregated risks per role, we are also interested in the individual risks, especially in those risks that have high risk scores and a high RPN. These are the risks to be aware of.

We have decided to set critical values (above this value we consider a risk to be major). We could have used a parato analysis for that (rank the scores from large to small, set the critical value such that 20% of the risks is above this value), however, we want to compare all three situations by setting equal critical values. Therefore we reason from a more general point of view. We set the critical value for the risk score at 9. We based this upon the fact that it is now the case that if probability and impact score a 3 (mid value) the critical value is met. Furthermore a 5 on either probability or impact can only be compensated with a 1 on the other dimension; otherwise the risk surpasses the critical value for the risk score to 9. For the RPN we chose 25 as critical value. With that critical value we know for sure that if 2 out of 3 dimensions (probability, impact, and manageability) score a 5, the risk will certainly meet the critical value.

Figure 5.5 and Figure 5.6 show the major risks in terms of risk score and RPN for the KD Rotterdam project.

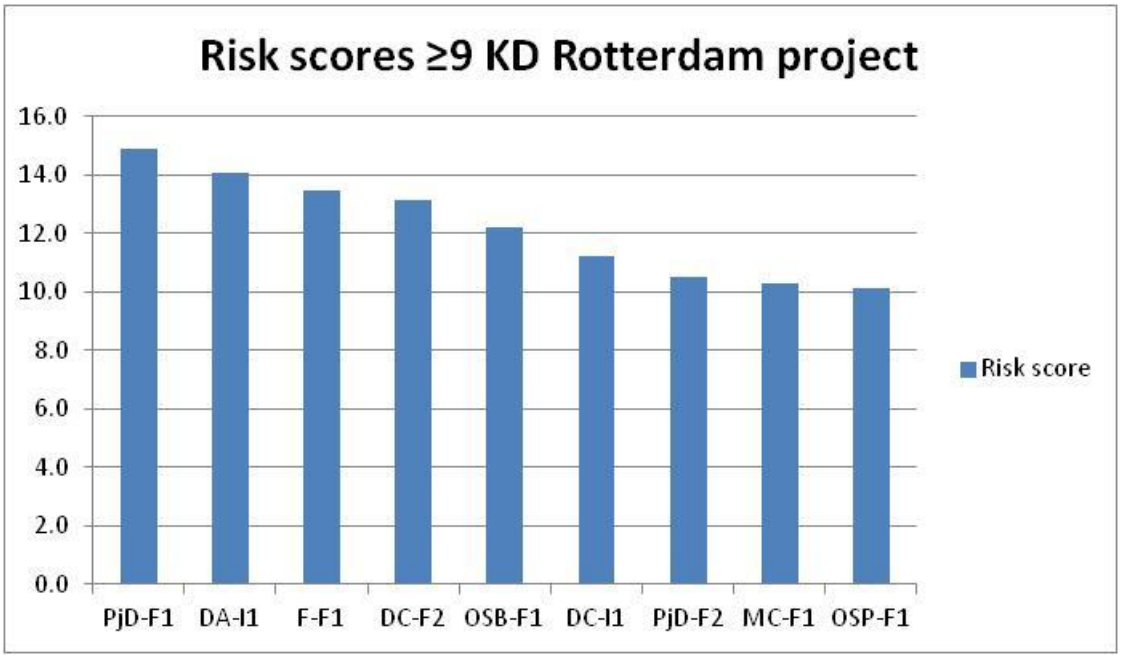


Figure 5.5: Risks with a risk score higher than or equal to 9 in the Karel Doorman Rotterdam project

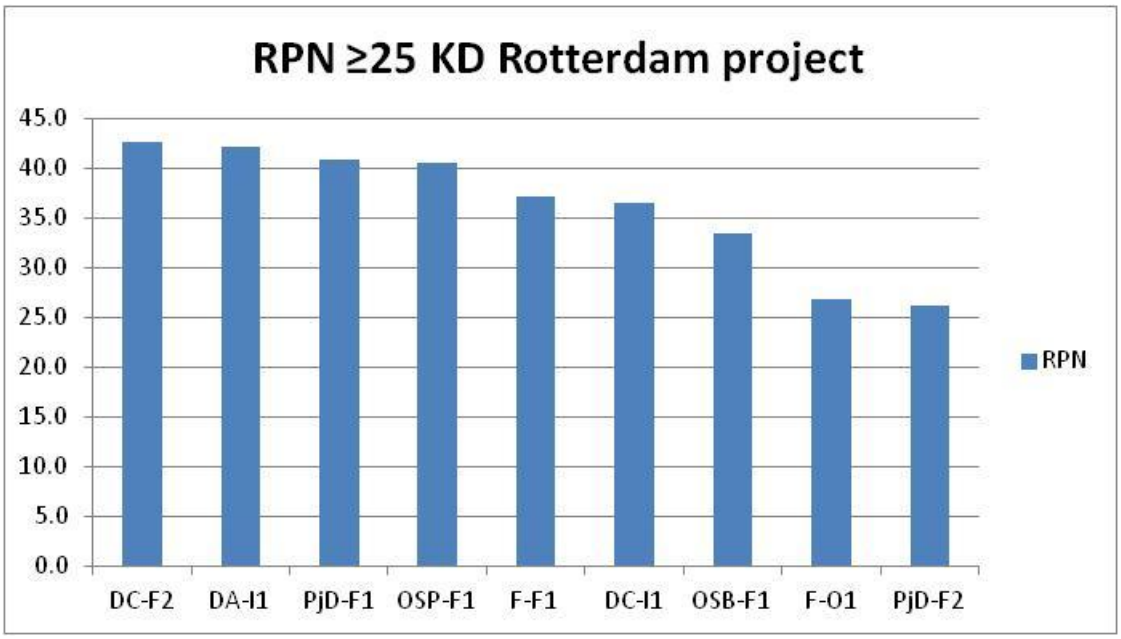


Figure 5.6: Risks with a RPN higher than or equal to 25 in the Karel Doorman project.

Remarkable risks are F-01, which has a critical RPN, but no critical Risk score, and MC-F1, for which the exact opposite counts.

In Figure 5.7 we combined the information that we obtained from Figure 5.5 and Figure 5.6. The upper right quadrant shows the risks that received a 9 or higher as risk score and a RPN of 25 or higher. The risks in that quadrant are the major risks in the value network of the Karel Doorman Rotterdam project.

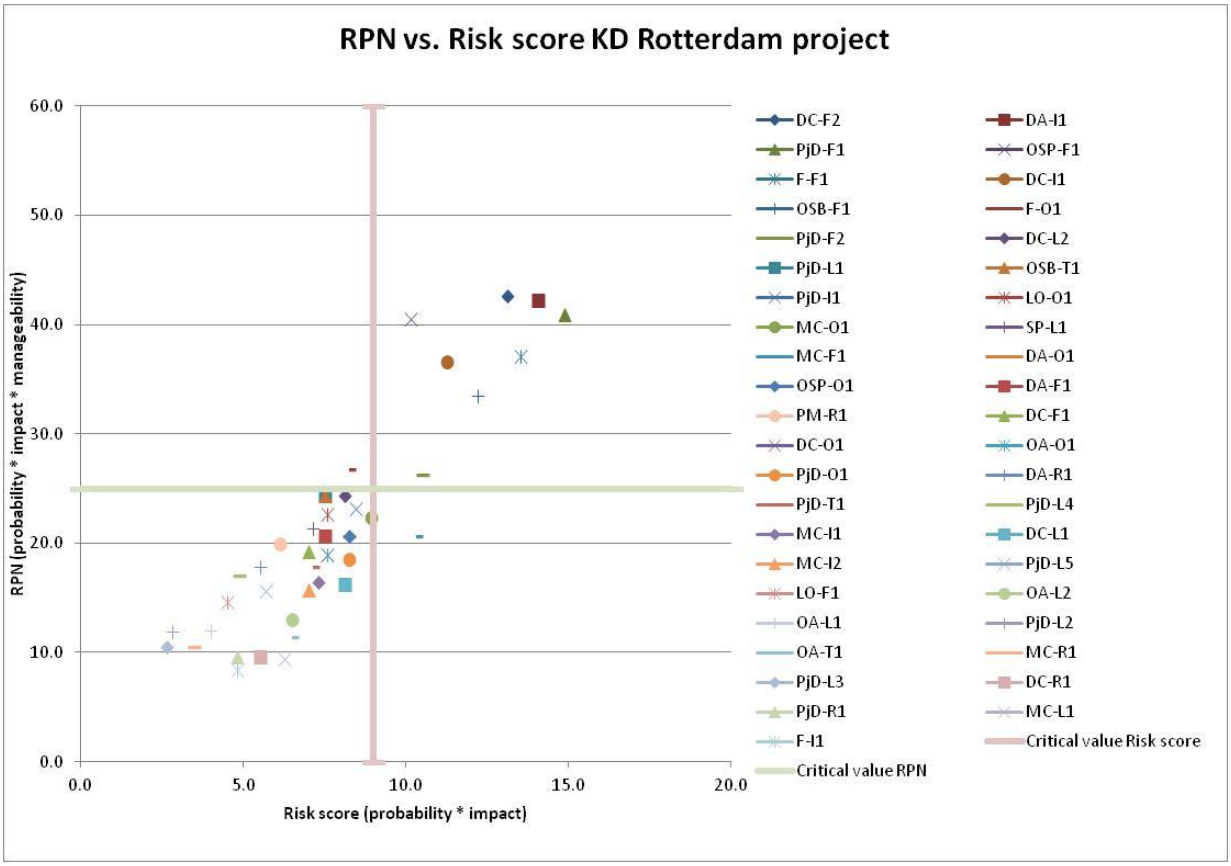


Figure 5.7 RPN and Risk score for all risks in the Karel Doorman Rotterdam project

These major risks are:

1. F-F1: Bankruptcy of project developer – Risk carried by *the financer*
2. PjD-F1: Overrun of investment costs – Risk carried by *the project developer*
3. DA-I1: Lack of /wrong information on end-user needs, whishes, and requirements – Risk carried by *the designer of the appearance (architect)*
4. DC-I1: Wrong information on the foundation and structural design of the substructure, which could lead to construction errors – Risk carried by *the designer of the construction*
5. DC-F2: Longer run time than expected , which leads to deferred revenues , which leads to cash flow problems – Risk carried by *the designer of the construction*
6. OSB-F1: The risk of not having the financial benefits as expected beforehand – Risk carried by *the owner of the sub structure*
7. PjD-F2: Loosing pre financing in case of a no go for the project – Risk carried by *the project developer*
8. OSP-F1: Vacancy risk – Risk carried by *the owner of the superstructure*

A remarkable conclusion is that there are 6 risks from the financial risk type in the major risk list and 2 risks of the input type, whereas no risks of the reputation, legislation & regulation, technical, or other type are present on this list.

We now analyze the individual risks in the 1st KD product situation in the same way. Figure 5.8 and Figure 5.9 show the risks that score a 9 or higher as Risk Score and the risk that score a 25 or higher as RPN. A remarkable risk is PD-SKD-I3. This ranks 9th based on its Risk Score but ranks 2st based on RPN. This means that this risk is hard to manage by *the supplier of the Karel Doorman.*

The total opposite counts for PD-SKD-01; this risk scores the 3rd on Risk Score, but does not surpass the critical value for its RPN. That must mean that this risk is within control of the responsible party (low score on manageability). This is explainable. The cooperation risk is manageable for the *supplier of the Karel Doorman product* role, since this is the largest role in value network. A large role means that this role has a lot of influence on who they want to work with. There are also risks that meet the critical value for RPN but not for the Risk Score, PD-OSP-F1 is an example of that. To find the major risks in the 1st Karel Doorman product situation we have to combine the information on risk scores and RPN.

Figure 5.8: Risks with risk scores higher than or equal to 9 for the 1st Karel Doorman product

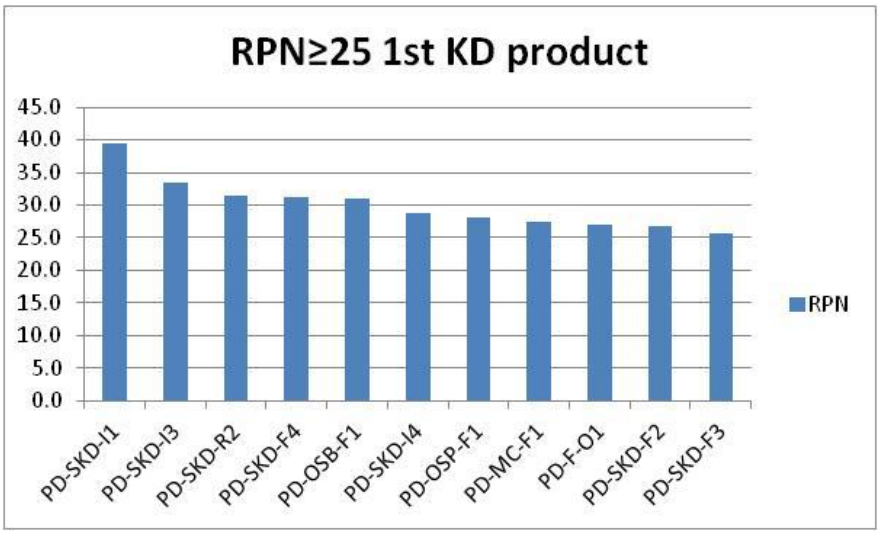


Figure 5.9: Risks with a RPN higher than or equal to 25 in the 1st Karel Doorman product

Figure 5.10 combines the Risks Scores and RPN of all risks in the 1st KD product situation. In the upper right quadrant we can find the major risks in this 1st KD product situation. We can immediately see that in this situation the risks in the upper right quadrant have moved towards the intersection of the critical values.

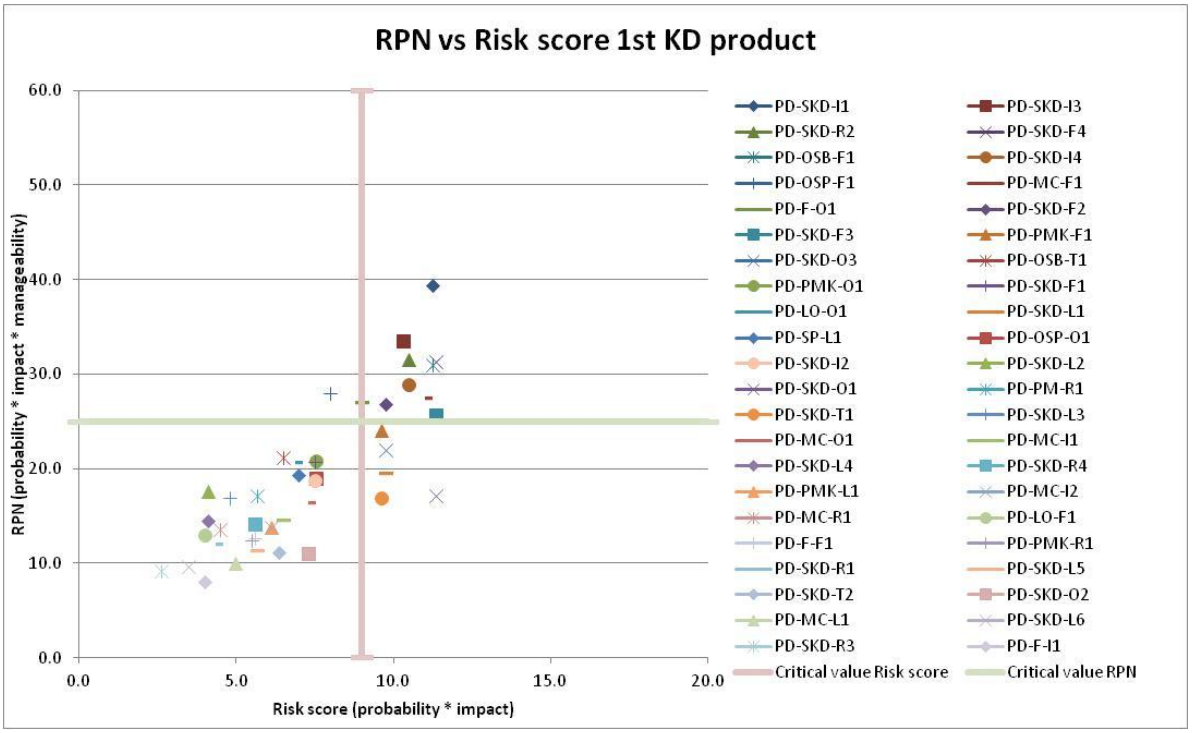


Figure 5.10:Risk score and RPN of all risks in the first Karel Doorman product situation

From Figure 5.10 we obtain a list with major risk. This list consists of the following risks:

1. PD-SKD-I3: Wrong or lack of information needed for the business case, such as information on market prices – This risk is carried by *the supplier of the Karel Doorman product*
2. PD-SKD-R2: In case of failure of the project it might be hard for the product supplier to get financing in later executions of the product – This risk is carried by *the supplier of the Karel Doorman product*
3. PD-F-O1: Cooperation risk – This risk is carried by *the financer*
4. PD-SKD-F4: Loosing pre financing in case of a no go for the project – The risk is carried by *the supplier of the Karel Doorman product*
5. PD-SKD-I1: Wrong information on the foundation and structural design of the substructure, which could lead to construction errors – The risk is carried by *the supplier of the Karel Doorman product*
6. PD-MC-F1: Exceeding budgeted building costs – This risk is carried by *the main contractor*
7. PD-OSB-F1: The risk of not having the financial benefits as expected beforehand – This risk is carried by *the owner of the substructure*

8. PD-SKD-F2: Longer run time than expected, which leads to deferred revenues, which leads to cash flow problems – This risk is carried by *the supplier of the Karel Doorman product*
9. PD-SKD-I4: Wrong or lack of information from project manager with local market knowledge – This risk is carried by *the supplier of the Karel Doorman product*
10. PD-SKD-F3: Overrun of investment costs – This risk is carried by *the supplier of the Karel Doorman product*

The first thing that we notice is an increase in the amount of major risks (from 8 to 10). They are however less severe compared to the KD Rotterdam project situation, since they have moved in the direction of intersection of the critical values. Furthermore we see that risks of the financial type are still clearly present; in this situation, 5 out of 10, so half, of the major risks are from the financial type. In this situation there is one major risk from the reputation type, whereas this risk type was absent in the major risk list of the project situation. The same counts for 1 risk of the type other. The other 3 major risks are from the input type. There are still no risks of the technical and legislation & reputation type present on the major risk list.

Another conclusion is that 7 out of 10 major risks are carried by *the supplier of the Karel Doorman product*. Finally we observed that one the highest risks in the project situation (F-F1: Bankruptcy of project developer – Risk carried by *the financer)* is not a major risk anymore. Remind that this risk has changed in to Bankruptcy of the supplier of the Karel Doorman product. We can explain this by a drop in probability. It is much more likely that a project developer goes bankrupt (due to the large amount of risky projects a project developer is typically involved in) than a supplier of product. This could change depending on the party that fulfils this role. If the party is typically known for its risky product portfolio, the probability score could increase again.

The last part of the analysis of individual risks consists of the analysis for the 5^{th}-10^{th} Karel Doorman product situation. We use the same format as we used for the other situations.

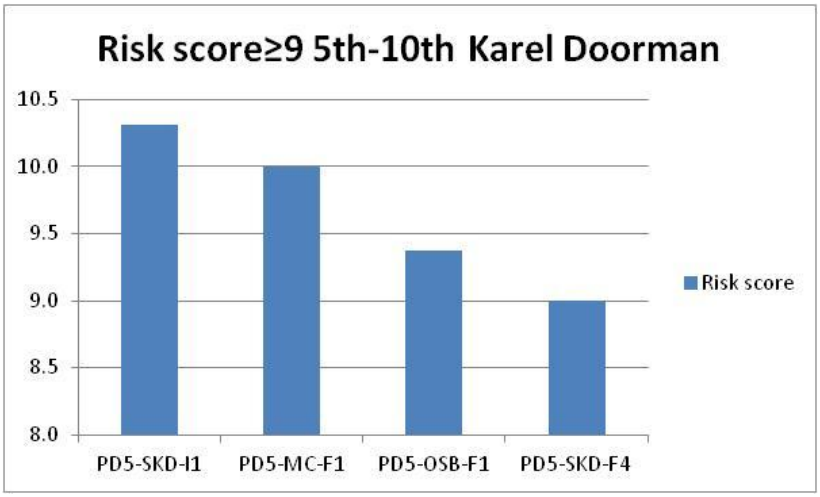


Figure 5.11: Risks with a risk score larger than or equal to 9 in the 5th-10th Karel Doorman product situation

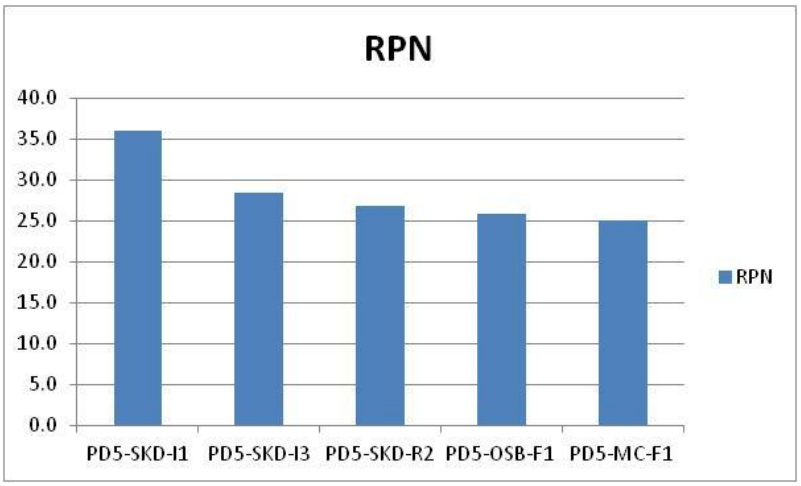


Figure 5.12: Risks with a RPN larger than or equal to 25 in the 5th-10th Karel Doorman product situation

We start with Figure 5.11 and Figure 5.12 from which we conclude that the amount of risks that surpass the critical risk values has decreased both compared to the project situation and the 1st product situation. Remarkable risks are PD5-SKD-I1 and PD5-SKD-R2, which have a critical RPN, but no critical risk score. The opposite counts for PD5-SKD-F4.

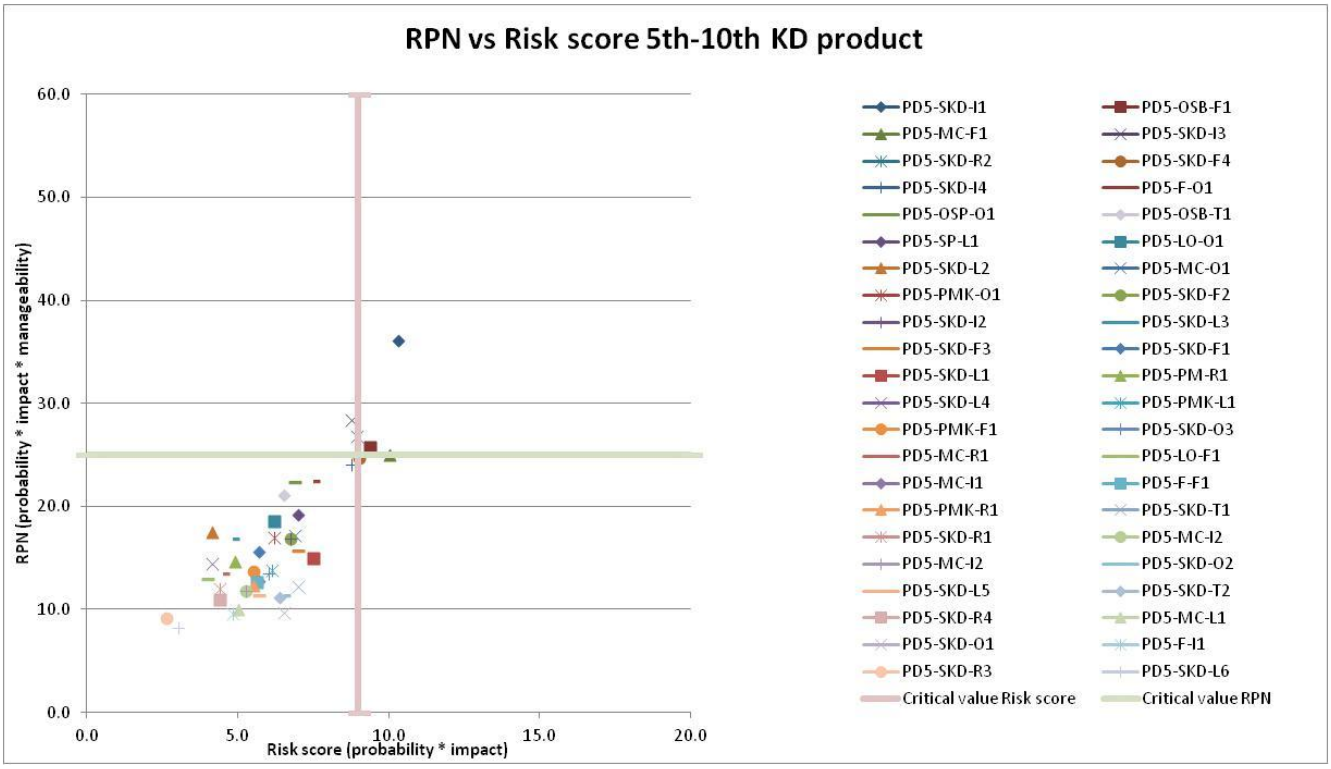


Figure 5.13: RPN and risk score for all risks in the 5th-10th Karel Doorman product situation

Figure 5.13 combines the RPN and risk score of every risk in the 5th-10th KD product situation. The first thing that we notice is that the amount of major risks has decreased both compared to the KD Rotterdam project situation (from 8, to 3) and the 1st KD product situation (from 10, to 3). Furthermore most of the risks in the upper right quadrant have moved to the intersection of the critical value lines again compared to the project and 1st product situation. Furthermore we can see that there is a clear highest, namely PD5-SKD-I1. The major risk list now consists of the following major risks:

1. PD5-MC-F1: Exceeding budgeted building costs – Risk carried by *the main contractor*
2. PD5-SKD-I1: Wrong information on the foundation and structural design of the substructure, which could lead to construction errors – The risk is carried by *the supplier of the Karel Doorman product*
3. PD5-OSB-F1: The risk of not having the financial benefits as expected beforehand – This risk is carried by *the owner of the substructure*

When analyzing this major risk list we notice that all 3 major risks can be found on the major risk list of the 1st Karel Doorman product as well. Furthermore it is clear that the major risk list for the 5th-10th product situation contains only one-third of the risks of the major risk list of the 1st product situation.

We furthermore observe that 1 out of 3 major risks are carried by *the supplier of the Karel Doorman product.* The remaining major risks are carried by *the main contractor* and *the*

owner of the substructure. The other roles do not carry a major risk anymore in this situation.

Concerning risk types we observe that 1 major risk belongs to the input type, and 2 to the financial type. The other types are not (longer) present.

We continue our analysis by zooming in on the roles that NSI most likely is to take within the value network in the three situations.

Zooming in on the NSI roles

In Table 5.8 we summarize the risks that are carried by the roles that NSI (or another part of Royal HaskoningDHV) most likely fulfils. For the project situation we know for sure that Royal HaskoningDHV fulfilled the role of *designer of the construction*. The bold scores are the largest scores on either Risk Score or RPN. As can be seen, in the 5th-10th KD product situation there is one risk that is both the largest on Risk Score and RPN.

Table 5.8: Overview of risks carried by NSI roles

	KD Rotterdam project	1st KD product	5th-10th KD product
Role	Designer of the construction	Supplier of the KD product	Supplier of the KD product
Amount of risks carried	7	23	23
Aggregated total risk (risk score; RPN)	(61;168)	(179;459)	(145;379)
Amount of major risks carried	2	7	1
Largest Risks carried (risk score; RPN)	DC-F2 (12.2;**44.8**) DC-I1 (**12.4**;37.3)	PD-SKD-F4 (**11.4**;31.3) PD-SKD-I1 (11.3; **39.4**)	PD5-SKD-I1 (**10.3**; **36.1**)

From the table above we see that the NSI (Royal HaskoningDHV) carries significantly more risks in the product situations compared to amount of risks in the project situation (from 7 to 23). This is also reflected in the total aggregated risk measured both as Risk Score and RPN.

Another more remarkable observation is the fact that the amount of major risks is almost 4 times bigger when we compare the project situation with the 1st product situation, but the difference between the project situation and 5th-10th product situation in terms of major risks carried is beneficial for NSI (from 2 to 1 major risks).

Finally we see that the largest risk that has to be carried by NSI (Royal HaskoningDHV) decreases if we compare the project situation with the 1st KD product situation. The decrease of the highest risk is even more visible in the 5th-10th KD product situation.

In the analyses above we made use of average of the four individual scores per element. This does not take into account the differences, or lack of consensus, between the four experts. In our opinion it is worse or more dangerous to underestimate the risks than to overestimate

the risks, and therefore we are interested in a worst-case scenario as well. In Appendix Ewe executed the same analyses as the ones that above, but in these analyses we took the most pessimistic score. We elaborate on the definition of the most pessimistic score in Appendix E as well.

5.4 BUSINESS CONSEQUENCES & GENERALIZATION OF THE RESULTS

Now that we analyzed the results of our case study, we continue exploring the business consequences of the changes that we see in the value network when the Karel Doorman project is turned into a replicable product. After that, we continue with analyzing to what extent we can generalize our case study results.

5.4.1 BUSINESS CONSEQUENCES

Now that we are aware of the changes in the value network in terms of roles and risks, we are interested in the business consequences of those changes for Royal HaskoningDHV, and especially NSI.

In the project situation NSI fulfils the role of the *designer of the construction,* in the product situation this changes to a role which we call *supplier of the Karel Doorman product.* These new role integrates several roles. By taking this role, NSI fulfils a much larger role than they did in the project situation. This is reflected in the amount of risk NSI carries as well. We foresee the following business consequences of taking a new role with the corresponding risks:

- NSI becomes a major player in the value network and functions as a system integrator.
- NSI has more power in the value network.
- NSI can ask other parties to fulfill a certain role in the network instead of being asked as a *designer of the construction.*
- The new role is larger and consists of elements that are outside the usual/core business of Royal HaskoningDHV (or at least the BL Buildings).
- The new role asks for skills and capabilities that are not needed in the traditional role, such as product marketing, product selling, and system integrating.
- In the new role distribution and sales channels are needed.
- In the new role a larger portion of the value network risk are carried by NSI, so the attitude towards risk taking should change from risk-adverse to risk-taking.
- In exchange for this larger risk portion NSI should claim a larger amount of the value network benefits. Therefore negotiation skills are needed.
- The amount of risk that have to be managed by NSI increases significantly, the attention paid to risk management should therefore increase as well. A clear system in which all risks can be secured is essential. In this system all information on risks of both on products that NSI is currently supplying and products that were sold in the

past, should be stored. Furthermore a clear method to assess the risks must be used for every new product; we recommend the RRBS method that we used in this case study.

5.4.2 GENERALIZATION OF THE RESULTS

To estimate to what extent our case study results can be generalized, we first check whether the Karel Doorman Rotterdam project resembles an average project that the BL Buildings is involved in.

The Karel Doorman Rotterdam project was a project conducted by the BU Hubs & Leisure. Most roles that were present in this project are commonly found in projects that the BL Buildings participates in. Almost all buildings are completed by a value network that consists of a *supplier of permission, an architect, a designer of the construction, other advisors, a project developer, a land owner,* and a *financer.* Usually there is specific client as well. In the Karel Doorman Rotterdam case, the client is somewhat embroiled. The owner of the super structure is the end client, but the owner of the sub structure can be seen as a client as well.

Furthermore, the role of the policy maker would not always be as clear as in the Karel Doorman case. Besides of the unusual inducement, and the unusual delay due to the real estate fraud scandal, the course and organization of the project is comparable to other project in which BL Buildings takes a role. In that sense we suspect that our case study results for the project situation can be generalized for all projects in which new technologies are developed. For projects where only existing techniques are used some risk (especially from the legislation & regulation type and the technical type) will be non-existent, or at least smaller compared to the Karel Doorman project.

We then have to consider the extent to which our case study results of the product situation can be generalized. Regarding the roles in a product situation we expect that for most product situation it will be the case that the product supplier appears as a new role. The definition of that role will strongly cohere with the value proposition and earning logic.

For example if NSI chooses for licensing the new role would be *supplier of the license* and the rest of the network would look more or less the same as during a project.

If *sweat equity* is chosen the role of supplier of the product will be more or less the same as in our case study, however that role would then be fulfilled by several parties. The business consequences for NSI can then differ from the business consequences in this case study, especially when the other parties that fulfill the role together with NSI have the capabilities, distribution channels, marketing knowledge that is needed, available. What also differs from our case study then is the amount of benefits that NSI can gain, since the benefits for the supplier role should be divided amongst more than one party.

Furthermore it is again the case that the role of a specific customer would be present in most product situations, which is in the case of a Karel Doorman product as embroiled as in its project situation, since there is an owner of the substructure and an owner of the superstructure. In other situations there will be a more univocal customer. In case of the 1st product we call this customer: *launching customer.* For the risks in the network this could mean that the input risks regarding wrong, or lack of information on customer whishes and needs, becomes less probable, and thus smaller.

For some products the role of *policy maker* would be less important or nonexistent. The corresponding risks of that role will then disappear or diminish as well.

Since NSI expects to turn new developments from project into products, we expect that the risks caused by unproven technology (absence of legislation and technical risks) can be found for other products as well. However, if we take a broader perspective outside NSI, it could be the case that for value networks where proven technologies are turned from projects into products, these risks will disappear or diminish.

5.5 CONCLUSIONS AND SUMMARY

Before we continue to the last chapter of this report, we end this chapter with a short summary and our conclusions of this chapter.

Summary

This chapter started with section 5.1 in which we elaborated on the history and execution of the Karel Doorman Rotterdam project. In this project a 16-storey apartment complex was placed upon the 'Ter-Meulen' building. The development that made this extension possible was an ultra-light weight steel and wood construction with two kernels at the backside of the building. This development was conducted at D3BN, a company which was taken over by DHV (now Royal HaskoningDHV).

In section 5.2 we reconstructed the relevant business elements for both the Karel Doorman Rotterdam project and a future Karel Doorman product. We made use of the RRBS method that we introduced in Chapter 4. After reconstructing the value proposition and earning logic we continued with the most important part, the value network. We started with the roles of which the network consists, followed by the risks that each of these roles has to carry. The risks are divided into several risk types: financial, input, reputation, legislation & regulation, technical, and other. Table 5.1 and Table 5.2 show the results. After that we quantified the risks by scoring the risks on probability, impact, and manageability. We distinguished between 3 situations namely: the KD Rotterdam project, the 1st KD product, and the 5th-10th KD product.

In section 5.3 we analyzed the roles and risks in those situations. We started with an analysis of the aggregated risk scores per role and the total amount of risk in the network. After that

we analyzed the individual risks and we ended with zooming in on the roles that NSI would take in both the project and product situations.

In section 5.4 we elaborated on the business consequences for NSI of taking the role of *Supplier of the Karel Doorman* instead of *designer of the construction.* We ended that section with our thought on the extent to which our case study results could be generalized.

Conclusions

In this chapter we answered the following sub questions:

2. *What did the network in terms of roles and risks look like during the Karel Doorman project?*
3. *What roles and risks in the network of a future Karel Doorman product are expected?*
4. *What similarities and differences can we find if we compare the roles and risks of the project network and the future product network?*
5. *What are the business consequences of these changes?*
6. *To what extent can we generalize the results of the Karel Doorman case?*

The answer on sub question 2 is the network that we presented in Table 5.1 and Table 5.3. Equivalent to that, the answer on sub question 3 is the network that we presented in Table 5.2, Table 5.4 and Table 5.5.

We answered sub question 4 in section 5.3. The main difference in terms of roles is the integration of four roles from the project situation into two roles in the product situations. We found the other roles to be similar in both the project and the product situation.

In terms of risks there are more differences and similarities. A remarkable similarity is the total amount of risk in terms of Risk Score in the value network in the project and 1st product situation. However, in the 5th-10th product situation we see a clear decrease in the total amount of risk in terms of Risk Score in the value network. In this light we can find a clear difference if we compare the total RPN of the value network. The total RPN in the value network decreases if the project is turned into a product, especially when the project is replicated several times. From this analysis our main conclusion is that especially replicating the product leads to a smaller amount of total risk carried by the value network in terms of Risk Score and RPN.

Another similarity is that most risks that we found in the project situation still exist in the product situation. Some of the risks have shifted to another role though, especially if the role was one of the 4 roles that integrated in to the 2 new roles in the product situations. In the product situation some new risk came up at the new roles, whereas the amount of parties that carry a cooperation risk has decreased.

We observed furthermore some clear differences. First of all we see a clear decrease in the amount of major risks in the value network if we compare the KD Rotterdam project

situation to the 5th-10th KD like product situation. If we however compare the KD Rotterdam project to the 1st KD like product situation we observed an increase in the amount in major risks. However, the severity of the major risks was less in the 1st KD product situation.

We found another difference when we compared the 1st product situation with the 5th-10th product situation. In that case, the amount of risk that is carried by the 2 new roles decreases clearly.

If we compare the roles that NSI would take in the three situations we see a large difference in the amount of risks. During a project NSI carries only 7 risks, whereas they carry 23 risks in both product situations. However, the increase in major risks is less radical, since this shifts from 2 in the project situation to 7 in the 1st product situation, but drops back to 1 in the 5th-10th product situation. Another remarkable observation in that light is the decrease in the risk quantity of the largest risk that NSI has to carry in that particular situation, if we compare the project situation to the 1st product situation, but even more in the 5th-10th product situation.

In section 5.4 we answered sub questions 5 and 6. The business consequences are based on the fact that NSI fulfils a larger role within the value network, to which they should adapt. The consequences include getting the right skills and capabilities on board. Furthermore a larger share of the benefits could and should be demanded by NSI. Also the risk attitude of the executive board should shift from risk-avoiding to somewhat more risk-taking. Since more risks are carried by NSI in the new role, NSI should put more emphasis on risk management as well.

Finally, we conclude that our case study results are to a large extent representative for other cases in which NSI likes to change project in to products. The main exception here lies in the role of the client. What we, however, should keep in mind is that our results are based on the experience, insights, and opinions of just four NSI experts. Therefore, we must emphasize the explorative character of our case study.

6 CONCLUSIONS & RECOMMENDATIONS

In Chapter 6 we discuss our conclusions and recommendations. In section 6.1 we draw conclusions on all former chapters and on the contribution of our research to theory. In section 6.2 we continue with our recommendations for NSI. In section 6.3 we elaborate on the limitations of this research, followed by our suggestions for further research.

6.1 CONCLUSIONS

Answers to our research questions and case study conclusions

Our research aims to answer a main research question and 6 sub questions. In Chapter 4 and 5 we answered our sub research questions, which combined lead us to an answer to our main research question. We therefore start with a short recapitulation of our answers to the sub questions, as can be found in Chapter 5 as well, before we continue with an answer to our main research question: *If the Karel Doorman project will be turned into a replicable product, what is the effect on the network that contributes to the realization of the building in terms of roles and risks and what are the business consequences of this effect?* For the extensive motivation for the answers beneath, we refer to Chapter 4 and Chapter 5.

1. *What is a suitable method to map the roles and risks in the network in a structured way?*
   To map the roles and risks in the network in a structured way we presented the RRBS. The RRBS is a method that we compiled from several methods that we found in literature. We presented an extensive overview of the methods that we found in literature in Section 3.3. We presented the RRBS and the corresponding logic behind the RRBS in Chapter 4.
2. *What did the network in terms of roles and risks look like during the Karel Doorman project?*
   By conducting the RRBS for the Karel Doorman Rotterdam project situation we were able to describe the network in terms of roles and risks in a structured way. We presented the result of the RRBS for this situation, and thus the network in terms of roles and risk, in Table 5.1 and Table 5.3. In the latter the risks were not only identified, but also quantified.
3. *What roles and risks in the network of a future Karel Doorman product are expected?*
   We obtained an answer to this sub question equivalent to our answer to sub question 2. We presented the result of the RRBS for this situation, and thus the network in terms of roles and risk, in Table 5.2 and Table 5.4 and Table 5.5. In the latter two, the risks were not only identified, but also quantified.
4. *What similarities and differences can we find if we compare the roles and risks of the project network and the future product network?*
   We answered this sub question in section 5.3. Our main conclusion is that the main difference in terms of roles is the integration of 4 roles from the project into 2 roles

in the product situations. We found the other roles to be similar in both the project and the product situation. In the KD Rotterdam project situation the largest role is that of *the project developer*, whereas the largest role in both product situations is the role of *the supplier of the Karel Doorman product.*

In terms of the risks we observed some major changes as well. A remarkable similarity is the total amount of risk in terms of Risk Score in the value network in the project and 1st product situation. However in the 5th-10th product situation we see a clear decrease in the total amount of risk in terms of Risk Score in the value network.

Looking at the total RPN in the value network we found a clear decrease in RPN if the KD project is turned in to a KD like product, especially when the project is replicated several times. From this analysis our main conclusion is that replicating the product leads to a smaller amount of total risk carried by the value network in terms of Risk Score and RPN.

Another similarity is that most risks that we found in the project situation still exist in the product situation. Some of the risks have shifted to another role though, especially if the role was one of the four roles of the project situation that integrated in to the two new roles in the product situations. In the product situation some new risks came up at those two new roles.

We observed furthermore some clear differences. First of all we see a clear decrease in the amount of major risks in the value network if we compare the KD Rotterdam project situation to the 5th-10th KD like product situation. If we, however, compare the KD Rotterdam project to the 1st KD product situation we observed an increase in the amount in major risks. The severity of the major risks was nevertheless lower in the 1st KD product situation, as well as the 5th-10th KD product situation.

We found another difference when we compared the 1st product situation with the 5th-10th product situation. In that case, the amount of risk that is carried by the 2 new roles decreases clearly.

If we compare the roles that NSI would take in the three situations we see large differences in the amount of risks. During a project NSI carries only 7 risks, whereas they carry 23 risks in both product situations. However, the increase in major risk is less radical, since this shifts from 2 in the project situation to 7 in the 1st product situation and but drops back to 1 in the 5th-10th product situation. Another remarkable observation in that light is the decrease in the risk quantity of the largest risk that NSI has to carry in that particular situation, if we compare the project situation to the 1st product situation, but even more in the 5th-10th product situation.

5. *What are the business consequences of these changes?*
   The business consequences are based on the fact that NSI fulfils a larger role within the value network of a product, to which they should adapt. The consequences include getting the right skills and capabilities on board. Furthermore a larger share of the benefits could and should be demanded by NSI. Also the risk attitude of the executive board should shift from risk-avoiding to somewhat more risk-taking. Since more risks are carried by NSI in the new role, NSI should put more emphasis on risk management as well.
6. *To what extent can we generalize the results of the Karel Doorman case?*
   Our case study results are to a large extent representative for other cases in which NSI likes to change project in to products. The main exception here lies in the role of the client.

Now that we provided a recapitulation of our answers to the sub questions we continue with an answer to the main research question.

If the Karel Doorman project is turned into a replicable product the effect will be that the value network changes both in terms of roles and risk. The main change in terms of roles is the integration of four roles into two roles. One of those new roles becomes the largest role in the value network. This role, *the supplier of the Karel Doorman,* is to be filled in by NSI. The role of *project developer,* which was an important role during the project, is divided over the two new roles. The other roles remain the same.

In terms of risks the effect of turning the KD Rotterdam project into a KD like product is that total amount of risk carried by the network decreases. We especially observed this in comparing the KD Rotterdam project situation, with the 5^{th}-10^{th} KD like product situation. The total amount of risk in the value network decreases significantly when the product is replicated. Other remarkable conclusions are the benefits for the role of the *financer* in terms of risks if the KD Rotterdam project is turned into a KD like product, and the shift of a lot of risks to *supplier of the KD product.*

The consequences for NSI are that they have to fill in a much larger role, which carries much more risks. The amount of major risks does increase as well if we consider the 1^{st} KD product situation. If we however consider the situation in which the product is replicated for several times the amount of major risks carried by NSI decreases. Furthermore the largest risk they have to carry is less severe in both product situations, compared to the KD Rotterdam project situation.

The business consequences adhere to the larger role. NSI must adapt to this larger role in which they have to do activities that are outside their regular business activities, and therefore involves skills and capabilities that may not be present (yet). Since more risks are carried, another consequence is that NSI should put a lot effort in risk management. A very

positive consequence of the larger role is that the portion of the network benefits for NSI should become larger as well.

Our conclusion is that the effects of turning a project into a product could be very beneficial for NSI and thus the company, if, and only if, NSI is able to adapt well to larger role in the product situation and the product is replicated several times. NSI should thereby focus on products that can be easily replicated several times, since the benefits are likely to increase due to learning effects and the risks decrease if a product is replicated several times.

Conclusion on the research's contribution to theory

Our research contributed to theory in that sense that we developed a method that is able to identify risks and roles, quantify risks, and to link risks to roles in the value network, in one overview. There are no existing methods, that we are aware of, that are able to do so. Furthermore our research contributed in resolving two major research gaps, namely: *insufficient knowledge on business model components in particular regarding interdependencies within and between them* and *absence of formalized means of representations as well as procedure model to allow a structured and comparable visualization of business models.* For the first gap we should, however, mention that our research just provides some first insights. We elaborate on this nuance in our 7th limitation in our section on limitations of our research.

6.2 RECOMMENDATIONS

In this section we provide NSI with recommendations on the implementation and use of the RRBS and the results that we obtained during our research. We present them clustered by theme:

(Re) use of the RRBS

1. First of all we recommend that NSI executes the RRBS for all earning logics that are taken into consideration for the future Karel Doorman product. This can help NSI to choose from the different earning logics, since the RRBS reveals the roles, and more important, the risks that are implied by that earning logic. NSI can make a decision then based on which role with what corresponding risks it is willing to play. We also recommend this approach for other future products of NSI.

2. To check whether the RRBS is a useful tool for NSI, our second recommendation is that for every risk that NSI gets exposed it is checked whether or not this risk was foreseen in the RRBS analysis. If many risks occur without being mentioned in the RRBS of that project or product, NSI should analyze what the cause is of this risk missing, and take corresponding measures. Adding a risk type to the RRBS or adding

an extra member to the team that fills out the RRBS with expertise in the field of the previous missed risks, are examples of measures that NSI could take.

3. Our third recommendation is that the roles and risks analysis, the RRBS, can be used as starting point for discussion with the other (targeted) parties in the value network. The amount of risks that a certain party takes is related to share of the revenues of the project/product that party can demand. Risks can be transferred between parties (and roles) by paying or receiving risk premiums. The RRBS forms a starting point in the negations on which role (and corresponding party) carries what risk to what share of revenues. An example: NSI takes the role of product supplier for the Karel Doorman product. NSI could share the RRBS results with other parties to show the risks that they are taking by picking up that role and ask for an appropriate risk premium. However, NSI could also try to transfer a risk that they do not want to carry to another party. Examples of risks that NSI may want to transfer are risks with a very high score on manageability, what means that they not in control of NSI.

4. Our fourth recommendation involves updating risks. As time evolves, so does knowledge on future risks. There are milestones in the development of a new product on which it important to (re)consider the roles and risks. Important milestones are for example the presence of a launching customer. Once NSI knows who the exact customer of their product will be, we recommend updating the roles and risks according to the new information on the context (location of the client). Another milestone would be that a certain role is filled in by a party. Based on the existing (or non-existing) relationship some risks may change as well. In general we could say that if major changes in information (on client, partner, competitor, location) appear, it would be useful to update the roles and risks analysis. In other words, NSI should use and update the RRBS as filter at the end of different stages is the innovation funnel, see Appendix F.

5. The fifth recommendation elaborates on the former recommendation and is to secure the risks (also when a risk was not recognized during the RRBS analysis) and corresponding consequences to which NSI actually gets exposed to. This information should not only be secured and stored in the project file, but also on an overview list for NSI projects and products. This list can be helpful in signaling risks for future project and products. It is therefore recommended to check in a RRBS session if the risks of this list apply for that specific case as well.

6. Our sixth recommendation is to reflect on the individual scores, since the method was new during the scoring of the Karel Doorman case. NSI should check whether they can come to consensus on the scores that varied a lot between experts. Afterwards, they should check whether the major risk lists are still valid. From our

worst-case scenario analysis we assume that our major conclusions on the decrease in total amount of risk carried in the value network, and the benefits of replicating the product remain valid after this reflection.

7. Our seventh recommendation would be to conduct the RRBS for several NSI initiatives. By doing so NSI has a supportive tool to decide on which initiatives are the most promising to focus on. The RRBS can provide useful insights on the role and risks that NSI has to take. If those are more favorable for one initiative than another, that favorable initiative could be given priority by NSI.

Selecting parties

8. Our eighth recommendation is to carefully select the other parties in the network of the Karel Doorman product to minimize several risks, such as the cooperation risk, but also risks of the technical and input type. Since NSI would be the supplier of the Karel Doorman which is a large role within the network with most risks involved, NSI could take a leading role within the network. To select the right parties for cooperation NSI should check whether NSI, Buildings, or even any business line of Royal HaskoningDHV has experience in cooperating with the party that is considered. If risks occur due to imputably failure of another party in the network, this should be secured and communicated, to prevent NSI or any other business unit of collaboration with this party in later projects or products without being aware of this party's failure history. On the other hand, we recommend to store and communicate very positive experiences as well. It can save a lot of time and trouble to cooperate with a party with whom NSI (or other Royal HaskoningDHV entities) has positive experience.

First product launch

9. The ninth recommendation concerns the most extreme form that NSI considers if a project is turned into a product, namely the form that involves being a supplier of a complete product with performance guarantees. In this case NSI is amongst others responsible for involving a financer in the value network. It is extremely important to develop the product 'the first time right'. If the first version is not successful in terms of customer satisfaction, product quality and, even more important, financial benefits, it would become extremely hard to get a second product financed.

10. Our eighth recommendation is aimed to be first time right as well. We recommend that NSI critically considers who the launching customer of a product should be. To make sure that the product launch is seen as a success NSI should check not only if the customer wants its product, but also if the product exactly fits the customer needs. For example, a customer shows great interest in buying the product, however

NSI feels that in the end the product is not the exact fit for the customer's needs, it might be a sensible decision to search for another launching customer. Otherwise it might be the case that the launching customer is not completely satisfied after all, which would not lead to a high amount of positive publicity, whereas positive publicity and feedback of the launching customer would serve as accelerant for product sales. The latter is interesting since we saw in our risk analysis that replicating the product has a positive impact on the amount and severity of the risks that have to be carried.

11. Our ninth recommendation regards the first product launch as well and involves getting the right people with the right skills on board. Since the role of a product supplier is much larger than the traditional role of designing consultant of the construction, more skills are involved. These skills include commercial skills and product marketing skills to sell the product to the right customer against the right price, risk analysis & monitoring skills to manage the large role with more varying risks, and supply chain knowledge to select the right distribution channels and to build the value network, with suitable and trustworthy other parties. If these skills and knowledge are not available within the company, we highly recommend to hire or to contract persons with these skills and knowledge.

6.3 LIMITATIONS & FURTHER REASEARCH

This section addresses the limitations of our research followed by recommendations for further research.

6.3.1 LIMITATIONS

As in every research, there are some limitations in our research as well. This subsection addresses those limitations.

1. The first limitation we see is the limited perspective on roles and risks. All roles and risks that we identified are identified from the perspective of NSI. It could be the case that if a party that mostly fulfills the role of for example project developer or financer identifies more, or other, risks. That could be risks that those parties take themselves, where NSI is not aware of.

2. Another, obvious, limitation is the fact that our research tries to predict the future in terms of roles and risks in a not yet existing situation, namely the (first) delivery of a Karel Doorman product. The future is always uncertain, which limits the conclusions of our research.

3. The third limitation is the fact that we have chosen to analyze the most drastic change in value proposition and earning logic, namely from providing construction design consultancy to delivery of a complete product including performance guarantees. As we already mentioned a lot of skills and knowledge are needed for the latter. We expect that this drastic change gave the most drastic shift in the value network (risks and roles) as well. If we had analyzed the value network after a less drastic change, for example providing a license with the earning logic of getting a license fee, our results may differ significantly from the results we obtained in our current research design. We expect fewer changes in the value network (in terms of roles and risks) in that case. However, our research (and thus conclusion) is limited to the case of a drastic change in value proposition and earning logic.

4. Although we assume that the structured approach for identifying risks leads to the most complete overview of risks, this structure itself is a limitation as well. If we, for some reason, miss a risk type in our approach, it might lead to a bias in which we structurally miss risks from that type. We mitigate this limitation as much as possible by adding the risk type 'other'. After the experience of releasing a product like Karel Doorman NSI could easily add a risk type if they feel that some important type is missing in the current RRBS.

5. Another major limitation of our research is that all of our results are based on the insights and opinions of a small group of people (n= 6 including the researcher for identifying roles and risks and n= 4 experts for quantifying risks) that discusses the transformation from projects to products on a regular basis. Furthermore the Karel Doorman is a common theme of the group discussions. On one hand this experience and familiarity with one other is important to identify and quantify risks and to overcome disadvantages of group dynamics (for example the disadvantage mentioned by Keizer et al. (2002) : 'People sometime hesitate to label factors as risky or not risky if opinion leaders within the group have a different view'). On the other hand it might be the case that this small group of people suffers from bias, which would be a limitation for our results, but also for executing the RRBS for other cases. The latter can be overcome by inviting external (from other business units, business lines or even other companies) attendants for a RRBS session. Finally, the effect on the average score of an expert that is very optimistic or pessimistic on risks is large in case of a small n.

6. The sixth limitation of our research is related to the risk quantifying part. We challenged the minds of the experts heavenly in quantifying the Karel Doorman Rotterdam project risks. They had to score the probability of a certain risk without taking in account whether the risk in reality occurred or not. Knowing that the human brain already has trouble with assessing risks, this extra obstacle for the brain might

have biased the results.

7. Finally a major limitation of our research concerns the contribution to the existing knowledge gap on the interdependencies between several business model elements. Due to our research design in which we want to measure the effect of changing two variables (*value proposition* and *earning logic*) on one other variable (*value network*), we cannot scientifically proof if there is causal relationship, since we are not sure what the exact relationship is between the two input variables. We suspect that there is a correlation between value *proposition* and *earning logic*, and maybe even a causal relationship, but we did not test that explicitly.

   From a theoretical point of view we should have separately tested the effect of changing the *value proposition* on the *value network*, and the effect of changing the *earning logic* on the *value network*. That would, however, not make sense from a practical point of view, since it is simply not possible to sell a product with performance guarantees (value proposition) without changing the earning logic as well, since the current earning logic *Amount of hours worked * hourly rate* is not applicable on the delivery of a product. The amount of hours worked cannot be determined. Furthermore it could be the case that other variables (elements of the business model) that do not fit within our research scope, interfere or correlate with our tested variables as well, and are the real cause for changes in value network.

6.3.2 FURTHER RESEARCH

In this subsection we provide suggestions for further research. We distinguish between suggestions for further research for NSI and/or other entities within Royal HaskoningDHV and suggestions for further research for further research for general scientific purpose.

NSI/ Royal HaskoningDHV

1. First of all the RRBS could be tested for more cases within NSI to check whether the method is indeed applicable for general purpose within the business unit. Maybe some new risk types pop up when the method is broadly tested.

2. Our second suggestion for further research continues from our first suggestion, as we suggest testing and using the RRBS within other business units or even other business lines, as a tool for project managers when managing project risks.

3. Another suggestion for further research is to use the RRBS to map the effect of other earning logics for a Karel Doorman product, that are now out of consideration, and to compare the results with the basic scenario of the Karel Doorman Rotterdam project. If the resulting value network of that earning logic is very promising for NSI it could

use the results in convincing the executive board of the use of that earning logic.

4. The fourth suggestion for further research is to extend the research on turning projects into product to other components of the Business Model. Examples of those components are strategic choices or market segments. These are components that we left out of consideration during our research. In addition to that expansion we would suggest to further investigate the effect that product delivery has on the skills and capacities that are needed. Major questions could be:
   What skills, capabilities and knowledge do we need?
   Do we have people with the right skills and knowledge?
   If so, do we have enough people with that skills and knowledge?
   If not, how can we obtain enough people with the right skills, knowledge, and capabilities (training current staff or hiring people)?

5. A fifth recommendation for further research would be a follow-up study. With that we mean a case study that verifies the results of our case study in a situation in which the product is already launched. Preferably the subject of the case study would be the Karel Doorman case as well, but if that is not possible another project that has been turned into a product already is also an interesting possibility.

6. Our last suggestion for further research within NSI would be to expand our case study by involving parties that are used to fulfill the roles that we defined. It would be very interesting to see if they come up with the same risks.

General scientific purpose

Whereas the former suggestion for further research focused on practical impact for NSI, the following suggestions for further research focus on general scientific impact.

1. A first recommendation in that light would be to further investigate the exact relationship between different components of a business model. This could be tried in the same context, but also in a totally different context, within or even without the construction industry. The components should be changed separately instead of two at the same time. The Karel Doorman case in which we compare a project situation with a product situation is not ideal to do so, since it is almost inevitable to change more than one variable to be realistic.

2. To see whether the RRBS is a general useful method we recommend to test it in other companies as well. We should note that the risk types may have to change, especially when the company operates in another industry.

3. Elaborating on the former recommendation, performing the RRBS from the perspective of a company that could fulfill a different role in a Karel Doorman product (or project) than NSI, would be very interesting to test the validity of RRBS. The more similarities between the RRBS of such companies and the RRBS we created, are found, the more valid the RRBS method is.

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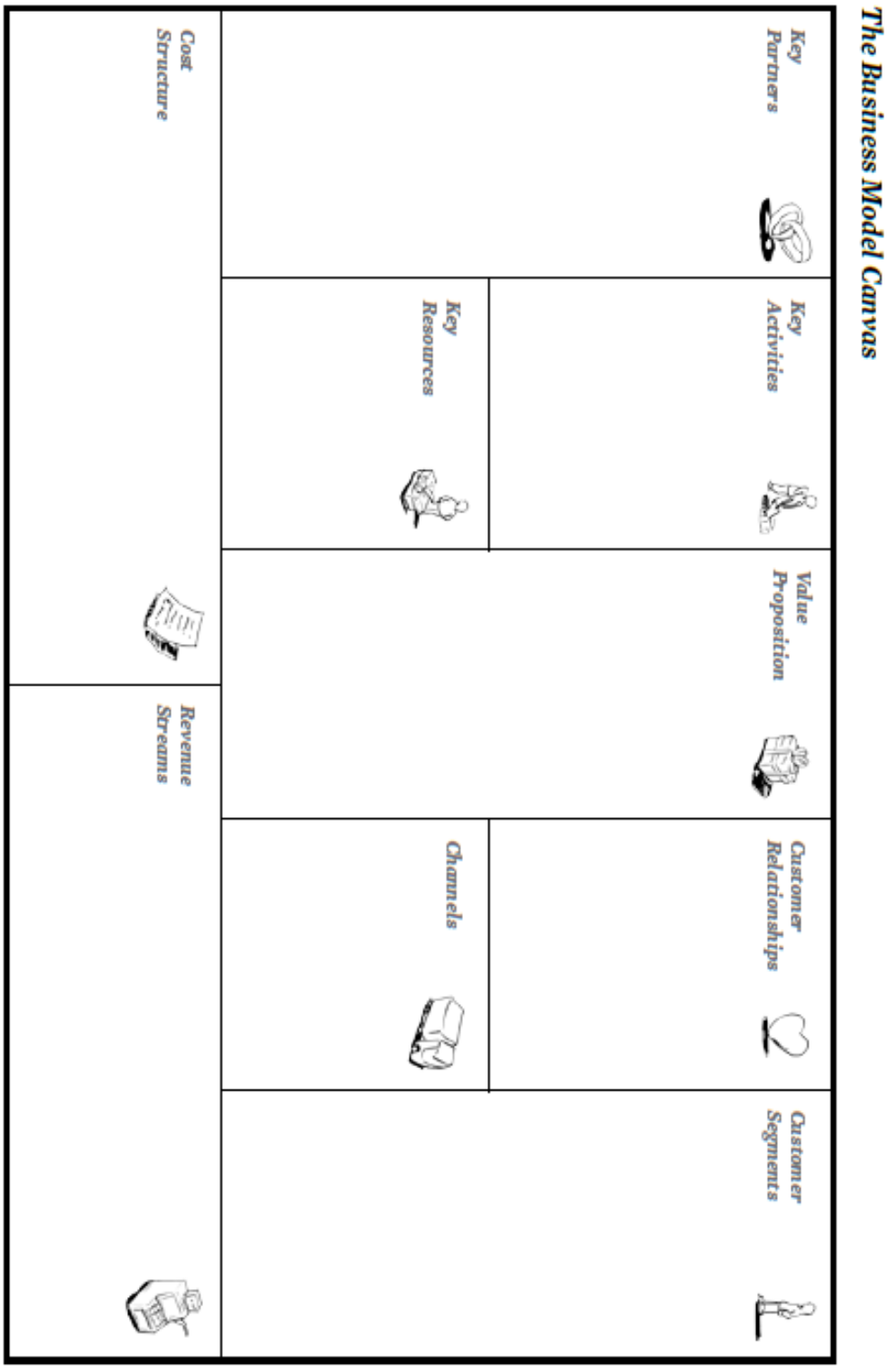
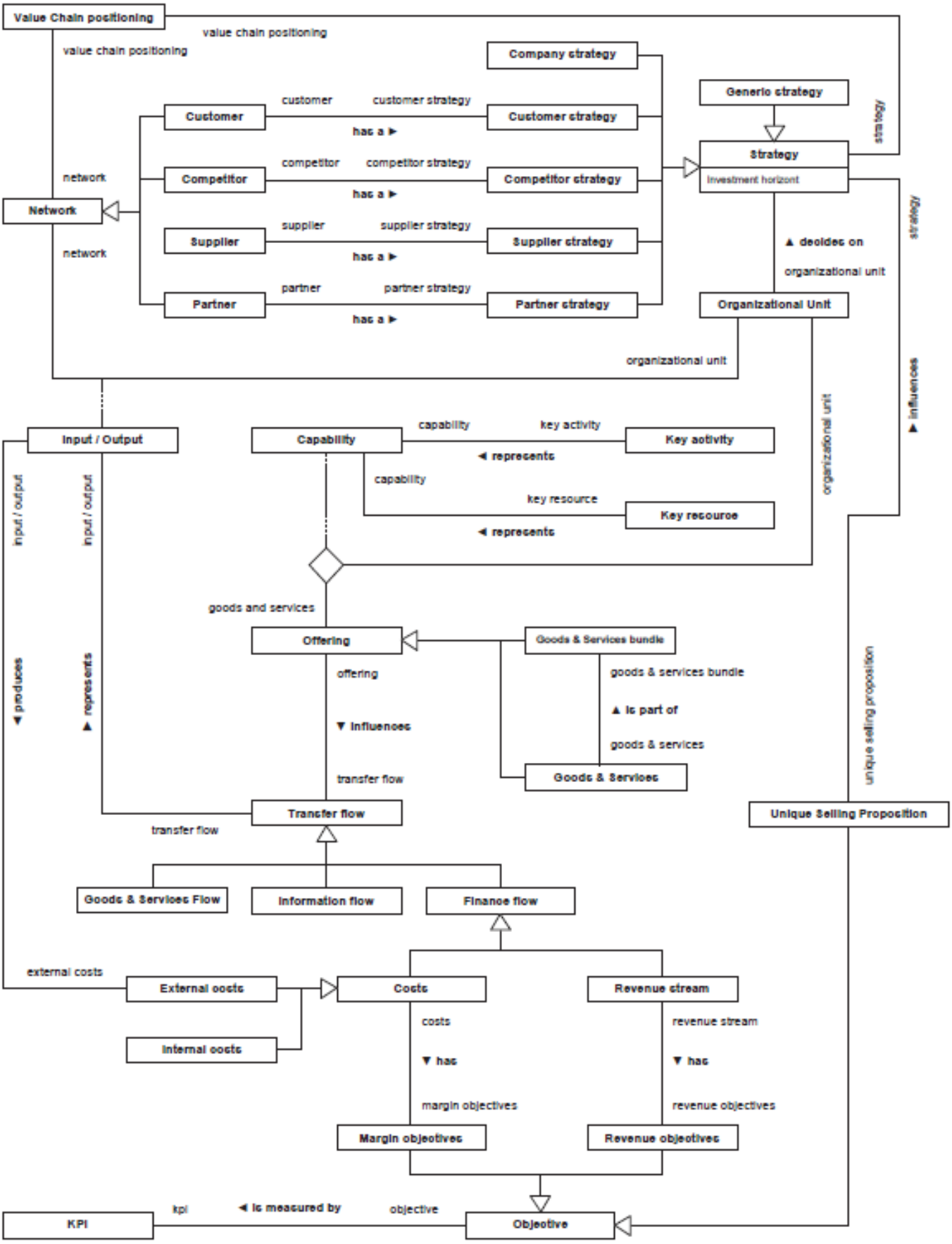
APPENDICES

A. LARGER FIGURES



The business model canvas, source: (Osterwalder & Pigneur, Business model generation, 2009)



Level 2: Core business model ontology (Burkhart, Schief, Vanderhaeghen, & Wolter, 2012)

B. RISK BREAKDOWN STRUCTURE NSI

Level 0 (network)	Level 1 (roles)	Level 2 (risk types)	Level 3 (relevant risks)	Probability	Impact	Risk score	Manageability	Risk Priority Number
Value network Risks	Role 1 _____	Financial						
		Input						
		Reputation						
		Legislation & Regulation						
		Technical						
		Other						
	Role 2 _____	Financial						
		Input						
		Reputation						
		Legislation & Regulation						
		Technical						
		Other						
	Role … _____	Financial						
		Input						
		Reputation						
		Legislation & Regulation						
		Technical						
		Other						
	Role N _____	Financial						
		Input						
		Reputation						
		Legislation & Regulation						
		Technical						
		Other						

C. RISK CODES

Tabe C.1: Risk codes Karel Doorman Rotterdam project

Role	Risk type	Risk	Risk code
Policy maker	Reputation	Failure of the project --> image damage -->?(forced) resignation of the alderman	PM-R1
Supplier of permission	Legislation & Regulation	Council of State decides otherwise on the planning permission --> result = no permission	SP-L1
Owner substructure	Financial	The risk of not having the financial benefits as expected beforehand	OSB-F1
Owner substructure	Technical	Damage to substructure	OSB-T1
Designer of the appearance	Financial	Having done unpaid pre work when the project is not executed in the end.	DA-F1
Designer of the appearance	Input	Lack of /wrong information on end-user needs, whishes, and requirements.	DA-I1
Designer of the appearance	Reputation	Negative public opinion on the appearance of the building.	DA-R1
Designer of the appearance	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	DA-O1
Designer of the construction	Financial	Having done unpaid pre work when the project is not executed in the end.	DC-F1
Designer of the construction	Financial	Longer run time than expected --> deferred revenues -->cash flow problems.	DC-F2
Designer of the construction	Input	Wrong information on the foundation and structural design of the substructure, which could lead to construction errors.	DC-I1
Designer of the construction	Reputation	Mistakes in the construction could lead to image damage	DC-R1
Designer of the construction	Legislation & Regulation	Claims of the project developer due to poor performance.	DC-L1
Designer of the construction	Legislation & Regulation	Absence of legislation, since unproven technologies are used.	DC-L2
Designer of the construction	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	DC-O1
Other advisors	Legislation & Regulation	Absence of legislation, since unproven technologies are used.	OA-L1
Other advisors	Legislation & Regulation	Claims of the project developer due to poor performance.	OA-L2
Other advisors	Technical	The risk of not being able to live up to the guarantees given.	OA-T1
Other advisors	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	OA-O1
Project developer	Financial	Overrun of investment costs (stichtingskosten)	PD-F1
Project developer	Financial	Loosing pre financing in case of a no go for the project.	PD-F2
Project developer	Input	Wrong /lack of information needed for the business case, such as information on market prices.	PD-I1
Project developer	Reputation	In case of failure of the project it might be hard for the project developer to get financing in later projects.	PD-R1
Project developer	Legislation & Regulation	Not getting the planning permission.	PD-L1

Project developer	Legislation & Regulation	Negative outcomes of an archaeological research.	PD-L2
Project developer	Legislation & Regulation	Negative impact of the Monuments Act.	PD-L3
Project developer	Legislation & Regulation	Changes in laws and regulation during the project execution.	PD-L4
Project developer	Legislation & Regulation	Claim from substructure owner in case of damage	PD-L5
Project developer	Technical	Malfunctioning of the final construction	PD-T1
Project developer	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-O1
Financer	Financial	Bankruptcy of project developer (not getting investment back).	F-F1
Financer	Input	Lack of information on financial health of project developer.	F-I1
Financer	Other	Cooperation risks	F-O1
Main contractor	Financial	Exceeding budgeted building costs	MC-F1
Main contractor	Input	Troubles with deliveries of building materials (late, incomplete, inferior quality).	MC-I1
Main contractor	Input	Mistakes in or misinterpretation of plans (drawings).	MC-I2
Main contractor	Reputation	Causing nuisance in the eyes of the public opinion.	MC-R1
Main contractor	Legislation & Regulation	Revoked licenses (noise permits, exit permits, etcetera)	MC-L1
Main contractor	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	MC-O1
Owner of superstructure	Financial	Vacancy risk (collapse of the housing market)	OSP-F1
Owner of superstructure	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	OSP-O1
Land owner	Financial	Opportunity costs	LO-F1
Land owner	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	LO-O1

Table C.2: Risk codes 1st Karel Doorman product and 5th-10th Karel Doorman product

Role	Risk type	Risk	Risk code 1st product	Risk code 5th-10th product
Policy maker	Reputation	Failure of the project --> image damage -->?(forced) resignation of the alderman	PD-PM-R1	PD5-PM-R1
Supplier of permission	Legislation & Regulation	Council of State decides otherwise on the planning permission --> result = no permission	PD-SP-L1	PD5-SP-L1
Owner substructure	Financial	The risk of not having the financial benefits as expected beforehand	PD-OSB-F1	PD5-OSB-F1
Owner substructure	Technical	Damage to substructure	PD-OSB-T1	PD5-OSB-T1
Supplier of the Karel Doorman product	Financial	Having done unpaid pre work when the project is not executed in the end.	PD-SKD-F1	PD5-SKD-F1
Supplier of KD product	Financial	Longer run time than expected --> deferred revenues -->cash flow problems.	PD-SKD-F2	PD5-SKD-F2
Supplier of KD product	Financial	Overrun of investment costs	PD-SKD-F3	PD5-SKD-F3
Supplier of KD product	Financial	Loosing pre financing in case of a no go for the project.	PD-SKD-F4	PD5-SKD-F4
Supplier of KD product	Input	Wrong information on the foundation and structural design of the substructure, which could lead to construction errors.	PD-SKD-I1	PD5-SKD-I1
Supplier of KD product	Input	Lack of information on end-user needs, whishes, and requirements.	PD-SKD-I2	PD5-SKD-I2
Supplier of KD product	Input	Wrong or lack of information needed for the business case	PD-SKD-I3	PD5-SKD-I3
Supplier of KD product	Input	Wrong or lack of information from project manager with local market knowledge.	PD-SKD-I4	PD5-SKD-I4
Supplier of KD product	Reputation	Image damage due to construction mistakes	PD-SKD-R1	PD5-SKD-R1
Supplier of KD product	Reputation	In case of failure of the project it might be hard for the product supplier to get financing in later executions of the product.	PD-SKD-R2	PD5-SKD-R2
Supplier of KD product	Reputation	Negative public opinion on the outlook of the building.	PD-SKD-R3	PD5-SKD-R3
Supplier of KD product	Reputation	Claims of the project developer due to poor performance.	PD-SKD-R4	PD5-SKD-R4
Supplier of KD product	Legislation & Regulation	Not getting the planning permission.	PD-SKD-L1	PD5-SKD-L1
Supplier of KD product	Legislation & Regulation	Negative outcomes of an archaeological research.	PD-SKD-L2	PD5-SKD-L2
Supplier of KD product	Legislation & Regulation	Negative impact of the Monuments Act.	PD-SKD-L3	PD5-SKD-L3
Supplier of KD product	Legislation & Regulation	Changes in laws and regulation during the product realization.	PD-SKD-L4	PD5-SKD-L4
Supplier of KD product	Legislation & Regulation	Claim of substructure owner in case of damage.	PD-SKD-L5	PD5-SKD-L5
Supplier of KD product	Legislation & Regulation	Absence of legislation, since unproven technologies are used.	PD-SKD-L6	PD5-SKD-L6
Supplier of KD product	Technical	The risk of not being able to live up to the guarantees given.	PD-SKD-T1	PD5-SKD-T1

Supplier of KD product	Technical	Malfunctioning of the final construction.	PD-SKD-T2	PD5-SKD-T2
Supplier of KD product	Other	Lack of expertise present in company to fulfill new role.	PD-SKD-O1	PD5-SKD-O1
Supplier of KD product	Other	Lack of capacity to develop several Karel Doorman products in parallel due to large role.	PD-SKD-O2	PD5-SKD-O2
Supplier of KD product	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-SKD-O3	PD5-SKD-O3
Project manager (with local market knowledge)	Financial	Underestimation of the costs (less profit since the project manager agreed upon a fixed fee).	PD-PMK-F1	PD5-PMK-F1
Project manager	Reputation	Not delivering proper local market information can lead to missing out on future orders.	PD-PMK-R1	PD5-PMK-R1
Project manager	Legislation & Regulation	Claim by the supplier of the product for not delivering proper local market knowledge.	PD-PMK-L1	PD5-PMK-L1
Project manager	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-PMK-O1	PD5-PMK-O1
Financer	Financial	Bankruptcy of supplier of the Karel Doorman product (not getting investment back).	PD-F-F1	PD5-F-F1
Financer	Input	Lack of information on financial health of supplier of the Karel Doorman product	PD-F-I1	PD5-F-I1
Financer	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-F-O1	PD5-F-O1
Main contractor	Financial	Exceeding budgeted building costs	PD-MC-F1	PD5-MC-F1
Main contractor	Input	Troubles with deliveries of building materials (late, incomplete, inferior quality).	PD-MC-I1	PD5-MC-I1
Main contractor	Input	Mistakes in or misinterpretation of plans (drawings).	PD-MC-I2	PD5-MC-I2
Main contractor	Reputation	Causing nuisance in the eyes of the public opinion.	PD-MC-R1	PD5-MC-R1
Main contractor	Legislation & Regulation	Revoked licenses (noise permits, exit permits, etcetera)	PD-MC-L1	PD5-MC-L1
Main contractor	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-MC-O1	PD5-MC-O1
Owner of superstructure	Financial	Vacancy risk (collapse of the housing market)	PD-OSP-F1	PD5-OSP-F1
Owner of superstructure	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-OSP-O1	PD5-OSP-O1
Land owner	Financial	Opportunity costs	PD-LO-F1	PD5-LO-F1
Land owner	Other	Cooperation risks (no/little common goals, opportunistic behavior of other parties, etc.)	PD-LO-O1	PD5-LO-O1

D. INDIVIDUAL RISK SCORES

In this appendix we provide all individual scores of the NSI experts. We added the averages to that. Furthermore we included the average probability, impact, and manageability over all risks per experts as the last row of Table D.1, Table D.2, and Table D.3. This gives an indication on how optimistic or pessimistic on risks the individual experts are.

Remind that P= probability, I= Impact, M= manageability.

Table D.1: Scores from all experts on probability, impact, and manageability in the Karel Doorman Rotterdam project situation

Risk code	P 1	P 2	P 3	P 4	P Ave-rage	I 1	I 2	I 3	I 4	I Ave-rage	M 1	M 2	M 3	M 4	M Ave-rage
PM-R1	2.0	2.0	1.0	2.0	1.8	3.0	5.0	3.0	3.0	3.5	3.0	4.0	4.0	2.0	3.3
SP-L1	1.0	2.0	2.0	1.0	1.5	4.0	5.0	5.0	5.0	4.8	2.0	3.0	3.0	4.0	3.0
OSB-F1	3.0	4.0	3.0	3.0	3.3	3.0	4.0	4.0	4.0	3.8	2.0	4.0	3.0	2.0	2.8
OSB-T1	2.0	2.0	2.0	2.0	2.0	4.0	3.0	4.0	4.0	3.8	3.0	4.0	4.0	2.0	3.3
DA-F1	3.0	5.0	4.0	3.0	3.8	3.0	1.0	2.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8
DA-I1	3.0	4.0	4.0	4.0	3.8	4.0	5.0	3.0	3.0	3.8	2.0	3.0	3.0	4.0	3.0
DA-R1	2.0	5.0	2.0	2.0	2.8	3.0	1.0	2.0	2.0	2.0	3.0	5.0	3.0	2.0	3.3
DA-O1	4.0	3.0	3.0	2.0	3.0	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
DC-F1	3.0	5.0	3.0	3.0	3.5	3.0	1.0	2.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8
DC-F2	3.0	5.0	3.0	3.0	3.5	4.0	5.0	3.0	3.0	3.8	3.0	4.0	4.0	2.0	3.3
DC-I1	3.0	3.0	2.0	4.0	3.0	4.0	5.0	3.0	3.0	3.8	3.0	2.0	4.0	4.0	3.3
DC-R1	2.0	2.0	2.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8	2.0	1.0	2.0	2.0	1.8
DC-L1	2.0	3.0	3.0	2.0	2.5	4.0	3.0	3.0	3.0	3.3	2.0	1.0	3.0	2.0	2.0
DC-L2	3.0	4.0	3.0	3.0	3.3	3.0	3.0	2.0	2.0	2.5	3.0	2.0	3.0	4.0	3.0
DC-O1	4.0	3.0	2.0	2.0	2.8	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
OA-L1	3.0	1.0	1.0	3.0	2.0	3.0	1.0	2.0	2.0	2.0	3.0	1.0	4.0	4.0	3.0
OA-L2	2.0	2.0	2.0	2.0	2.0	4.0	3.0	3.0	3.0	3.3	2.0	1.0	3.0	2.0	2.0
OA-T1	2.0	2.0	2.0	2.0	2.0	4.0	3.0	3.0	3.0	3.3	2.0	1.0	2.0	2.0	1.8
OA-O1	4.0	3.0	2.0	2.0	2.8	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
PjD-F1	3.0	4.0	4.0	3.0	3.5	5.0	4.0	4.0	4.0	4.3	3.0	3.0	3.0	2.0	2.8
PjD-F2	3.0	4.0	4.0	3.0	3.5	2.0	4.0	3.0	3.0	3.0	2.0	3.0	3.0	2.0	2.5
PjD-I1	3.0	1.0	3.0	2.0	2.3	4.0	5.0	3.0	3.0	3.8	2.0	2.0	3.0	4.0	2.8
PjD-R1	2.0	1.0	2.0	2.0	1.8	2.0	1.0	4.0	4.0	2.8	2.0	1.0	3.0	2.0	2.0
PjD-L1	2.0	3.0	3.0	2.0	2.5	4.0	4.0	2.0	2.0	3.0	3.0	4.0	4.0	2.0	3.3
PjD-L2	1.0	1.0	2.0	1.0	1.3	2.0	1.0	3.0	3.0	2.3	4.0	5.0	4.0	4.0	4.3
PjD-L3	2.0	1.0	2.0	1.0	1.5	2.0	1.0	2.0	2.0	1.8	4.0	5.0	4.0	3.0	4.0
PjD-L4	2.0	1.0	2.0	1.0	1.5	4.0	1.0	4.0	4.0	3.3	5.0	1.0	4.0	4.0	3.5
PjD-L5	2.0	1.0	3.0	1.0	1.8	3.0	4.0	3.0	3.0	3.3	3.0	4.0	2.0	2.0	2.8
PjD-T1	2.0	1.0	2.0	1.0	1.5	4.0	5.0	5.0	5.0	4.8	2.0	4.0	2.0	2.0	2.5
PjD-O1	4.0	3.0	3.0	2.0	3.0	2.0	5.0	2.0	2.0	2.8	3.0	2.0	2.0	2.0	2.3

F-F1	3.0	5.0	3.0	1.0	3.0	5.0	5.0	4.0	4.0	4.5	2.0	4.0	3.0	2.0	2.8
F-I1	2.0	1.0	3.0	1.0	1.8	2.0	5.0	2.0	2.0	2.8	1.0	1.0	3.0	2.0	1.8
F-O1	4.0	3.0	3.0	2.0	3.0	2.0	5.0	2.0	2.0	2.8	3.0	5.0	3.0	2.0	3.3
MC-F1	2.0	3.0	4.0	2.0	2.8	5.0	4.0	3.0	3.0	3.8	2.0	2.0	2.0	2.0	2.0
MC-I1	2.0	3.0	3.0	1.0	2.3	3.0	4.0	3.0	3.0	3.3	2.0	2.0	3.0	2.0	2.3
MC-I2	1.0	3.0	3.0	1.0	2.0	4.0	4.0	3.0	3.0	3.5	2.0	2.0	3.0	2.0	2.3
MC-R1	2.0	1.0	2.0	2.0	1.8	3.0	1.0	2.0	2.0	2.0	3.0	3.0	4.0	2.0	3.0
MC-L1	2.0	4.0	2.0	2.0	2.5	3.0	3.0	2.0	2.0	2.5	1.0	1.0	2.0	2.0	1.5
MC-O1	4.0	3.0	4.0	2.0	3.3	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
OSP-F1	3.0	1.0	3.0	2.0	2.3	5.0	5.0	4.0	4.0	4.5	3.0	5.0	4.0	4.0	4.0
OSP-O1	4.0	3.0	3.0	2.0	3.0	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
LO-F1	3.0	1.0	2.0	2.0	2.0	2.0	1.0	3.0	3.0	2.3	2.0	5.0	3.0	3.0	3.3
LO-O1	4.0	3.0	2.0	2.0	2.8	2.0	5.0	2.0	2.0	2.8	3.0	4.0	3.0	2.0	3.0
Average	*2.6*	*2.7*	*2.6*	*2.0*	*2.5*	*3.1*	*3.6*	*2.8*	*2.8*	*3.1*	*2.6*	*2.9*	*3.0*	*2.5*	*2.7*

Table D.2: Scores from all experts on probability, impact, and manageability in the 1st Karel Doorman like product situation

Risk code	P 1	P 2	P 3	P 4	P ave-rage	I 1	I 2	I 3	I 4	I ave-rage	M1	M2	M3	M4	M ave-rage
PD-PM-R1	2.0	2.0	1.0	2.0	1.8	3.0	5.0	2.0	3.0	3.3	2.0	4.0	4.0	2.0	3.0
PD-SP-L1	2.0	2.0	2.0	1.0	1.8	4.0	5.0	2.0	5.0	4.0	2.0	3.0	3.0	3.0	2.8
PD-OSB-F1	2.0	4.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	3.8	2.0	4.0	3.0	2.0	2.8
PD-OSB-T1	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0	3.3	3.0	4.0	4.0	2.0	3.3
PD-SKD-F1	3.0	5.0	4.0	3.0	3.8	2.0	1.0	3.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8
PD-SKD-F2	3.0	5.0	3.0	2.0	3.3	4.0	3.0	2.0	3.0	3.0	2.0	3.0	4.0	2.0	2.8
PD-SKD-F3	3.0	3.0	4.0	3.0	3.3	3.0	3.0	4.0	4.0	3.5	3.0	2.0	2.0	2.0	2.3
PD-SKD-F4	3.0	5.0	3.0	3.0	3.5	3.0	3.0	4.0	3.0	3.3	2.0	4.0	3.0	2.0	2.8
PD-SKD-I1	3.0	3.0	2.0	4.0	3.0	4.0	3.0	5.0	3.0	3.8	3.0	3.0	4.0	4.0	3.5
PD-SKD-I2	2.0	2.0	4.0	2.0	2.5	4.0	3.0	2.0	3.0	3.0	2.0	3.0	3.0	2.0	2.5
PD-SKD-I3	2.0	4.0	3.0	2.0	2.8	4.0	4.0	4.0	3.0	3.8	2.0	5.0	3.0	3.0	3.3
PD-SKD-I4	3.0	4.0	3.0	2.0	3.0	4.0	4.0	3.0	3.0	3.5	2.0	4.0	2.0	3.0	2.8
PD-SKD-R1	2.0	2.0	1.0	2.0	1.8	4.0	2.0	2.0	2.0	2.5	3.0	4.0	2.0	2.0	2.8
PD-SKD-R2	2.0	5.0	3.0	2.0	3.0	3.0	3.0	4.0	4.0	3.5	3.0	4.0	3.0	2.0	3.0
PD-SKD-R3	1.0	2.0	1.0	2.0	1.5	2.0	2.0	1.0	2.0	1.8	3.0	5.0	4.0	2.0	3.5
PD-SKD-R4	2.0	2.0	3.0	2.0	2.3	2.0	2.0	3.0	3.0	2.5	2.0	3.0	3.0	2.0	2.5
PD-SKD-L1	3.0	4.0	3.0	2.0	3.0	5.0	3.0	3.0	2.0	3.3	0.0	3.0	3.0	2.0	2.0
PD-SKD-L2	1.0	2.0	2.0	1.0	1.5	2.0	4.0	2.0	3.0	2.8	4.0	5.0	4.0	4.0	4.3
PD-SKD-L3	2.0	2.0	2.0	1.0	1.8	2.0	4.0	3.0	2.0	2.8	4.0	3.0	4.0	3.0	3.5
PD-SKD-L4	2.0	1.0	2.0	1.0	1.5	4.0	1.0	2.0	4.0	2.8	5.0	1.0	4.0	4.0	3.5
PD-SKD-L5	2.0	1.0	3.0	1.0	1.8	3.0	4.0	3.0	3.0	3.3	3.0	1.0	2.0	2.0	2.0
PD-SKD-L6	2.0	1.0	2.0	2.0	1.8	3.0	1.0	2.0	2.0	2.0	3.0	1.0	4.0	3.0	2.8
PD-SKD-T1	4.0	2.0	3.0	2.0	2.8	5.0	3.0	3.0	3.0	3.5	2.0	1.0	2.0	2.0	1.8
PD-SKD-T2	2.0	1.0	2.0	1.0	1.5	4.0	5.0	3.0	5.0	4.3	2.0	1.0	2.0	2.0	1.8
PD-SKD-O1	3.0	4.0	4.0	2.0	3.3	4.0	5.0	3.0	2.0	3.5	2.0	1.0	2.0	1.0	1.5
PD-SKD-O2	3.0	4.0	1.0	1.0	2.3	4.0	5.0	3.0	1.0	3.3	2.0	1.0	2.0	1.0	1.5
PD-SKD-O3	3.0	3.0	4.0	2.0	3.0	2.0	5.0	4.0	2.0	3.3	3.0	2.0	2.0	2.0	2.3
PD-PMK-F1	2.0	3.0	4.0	2.0	2.8	4.0	5.0	2.0	3.0	3.5	3.0	2.0	3.0	2.0	2.5
PD-PMK-R1	2.0	2.0	2.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8	2.0	3.0	2.0	2.0	2.3
PD-PMK-L1	1.0	2.0	3.0	1.0	1.8	3.0	5.0	4.0	2.0	3.5	2.0	3.0	2.0	2.0	2.3
PD-PMK-O1	3.0	3.0	3.0	2.0	2.8	2.0	5.0	2.0	2.0	2.8	3.0	2.0	4.0	2.0	2.8
PD-F-F1	1.0	2.0	1.0	1.0	1.3	4.0	5.0	5.0	4.0	4.5	2.0	1.0	4.0	2.0	2.3
PD-F-I1	1.0	2.0	4.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	3.0	2.0	2.0
PD-F-O1	3.0	3.0	4.0	2.0	3.0	2.0	5.0	3.0	2.0	3.0	3.0	4.0	3.0	2.0	3.0
PD-MC-F1	1.0	4.0	4.0	2.0	2.8	5.0	4.0	4.0	3.0	4.0	3.0	3.0	2.0	2.0	2.5
PD-MC-I1	2.0	2.0	3.0	1.0	2.0	3.0	4.0	3.0	3.0	3.3	2.0	2.0	3.0	2.0	2.3
PD-MC-I2	1.0	2.0	3.0	1.0	1.8	4.0	4.0	3.0	3.0	3.5	2.0	2.0	3.0	2.0	2.3
PD-MC-R1	2.0	3.0	2.0	2.0	2.3	3.0	1.0	2.0	2.0	2.0	3.0	3.0	4.0	2.0	3.0

PD-MC-L1	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.0	2.5	1.0	3.0	2.0	2.0	2.0
PD-MC-O1	3.0	4.0	4.0	2.0	3.3	2.0	3.0	2.0	2.0	2.3	3.0	1.0	3.0	2.0	2.3
PD-OSP-F1	2.0	1.0	3.0	2.0	2.0	5.0	5.0	2.0	4.0	4.0	3.0	5.0	4.0	2.0	3.5
PD-OSP-O1	3.0	3.0	3.0	2.0	2.8	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
PD-LO-F1	3.0	1.0	2.0	2.0	2.0	2.0	1.0	2.0	3.0	2.0	2.0	5.0	3.0	3.0	3.3
PD-LO-O1	3.0	3.0	2.0	2.0	2.5	2.0	5.0	2.0	2.0	2.8	3.0	4.0	3.0	2.0	3.0
Average	*2.3*	*2.7*	*2.7*	*1.9*	*2.4*	*3.2*	*3.6*	*2.8*	*2.8*	*3.1*	*2.5*	*2.9*	*3.0*	*2.2*	*2.6*

Table D.3: Scores from all experts on probability, impact, and manageability in the 5th-10th Karel Doorman like product situation

Risk code	P1	P2	P3	P4	P average	I1	I2	I3	I4	I average	M1	M2	M3	M4	M average
PD5-PM-R1	1.0	2.0	1.0	2.0	1.5	3.0	5.0	2.0	3.0	3.3	2.0	4.0	4.0	2.0	3.0
PD5-SP-L1	2.0	2.0	2.0	1.0	1.8	4.0	5.0	2.0	5.0	4.0	2.0	3.0	3.0	3.0	2.8
PD5-OSB-F1	1.0	4.0	2.0	3.0	2.5	3.0	4.0	4.0	4.0	3.8	2.0	4.0	3.0	2.0	2.8
PD5-OSB-T1	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0	3.3	3.0	4.0	4.0	2.0	3.3
PD5-SKD-F1	2.0	5.0	3.0	3.0	3.3	2.0	1.0	2.0	2.0	1.8	2.0	5.0	2.0	2.0	2.8
PD5-SKD-F2	2.0	3.0	2.0	2.0	2.3	4.0	3.0	2.0	3.0	3.0	2.0	2.0	4.0	2.0	2.5
PD5-SKD-F3	1.0	2.0	3.0	2.0	2.0	3.0	3.0	4.0	4.0	3.5	3.0	2.0	2.0	2.0	2.3
PD5-SKD-F4	3.0	5.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	4.0	3.0	2.0	2.8
PD5-SKD-I1	3.0	2.0	2.0	4.0	2.8	4.0	3.0	5.0	3.0	3.8	3.0	3.0	4.0	4.0	3.5
PD5-SKD-I2	2.0	2.0	3.0	2.0	2.3	4.0	3.0	2.0	3.0	3.0	2.0	3.0	3.0	2.0	2.5
PD5-SKD-I3	1.0	4.0	3.0	2.0	2.5	4.0	4.0	3.0	3.0	3.5	2.0	5.0	3.0	3.0	3.3
PD5-SKD-I4	2.0	4.0	2.0	2.0	2.5	4.0	4.0	3.0	3.0	3.5	2.0	4.0	2.0	3.0	2.8
PD5-SKD-R1	2.0	2.0	1.0	2.0	1.8	4.0	2.0	2.0	2.0	2.5	3.0	4.0	2.0	2.0	2.8
PD5-SKD-R2	1.0	5.0	3.0	2.0	2.8	3.0	3.0	3.0	4.0	3.3	3.0	4.0	3.0	2.0	3.0
PD5-SKD-R3	1.0	2.0	1.0	2.0	1.5	2.0	2.0	1.0	2.0	1.8	3.0	5.0	4.0	2.0	3.5
PD5-SKD-R4	1.0	1.0	3.0	2.0	1.8	2.0	2.0	3.0	3.0	2.5	2.0	3.0	3.0	2.0	2.5
PD5-SKD-L1	3.0	4.0	2.0	1.0	2.5	5.0	3.0	2.0	2.0	3.0	0.0	3.0	3.0	2.0	2.0
PD5-SKD-L2	1.0	2.0	2.0	1.0	1.5	2.0	4.0	2.0	3.0	2.8	4.0	5.0	4.0	4.0	4.3
PD5-SKD-L3	2.0	2.0	2.0	1.0	1.8	2.0	4.0	3.0	2.0	2.8	4.0	3.0	4.0	3.0	3.5
PD5-SKD-L4	2.0	1.0	2.0	1.0	1.5	4.0	1.0	2.0	4.0	2.8	5.0	1.0	4.0	4.0	3.5
PD5-SKD-L5	2.0	1.0	3.0	1.0	1.8	3.0	4.0	3.0	3.0	3.3	3.0	1.0	2.0	2.0	2.0
PD5-SKD-L6	2.0	1.0	2.0	1.0	1.5	3.0	1.0	2.0	2.0	2.0	3.0	1.0	4.0	3.0	2.8
PD5-SKD-T1	2.0	2.0	2.0	2.0	2.0	5.0	3.0	3.0	3.0	3.5	2.0	1.0	2.0	2.0	1.8
PD5-SKD-T2	2.0	1.0	2.0	1.0	1.5	4.0	5.0	3.0	5.0	4.3	2.0	1.0	2.0	2.0	1.8
PD5-SKD-O1	1.0	3.0	3.0	1.0	2.0	4.0	5.0	2.0	2.0	3.3	2.0	1.0	2.0	1.0	1.5
PD5-SKD-O2	2.0	2.0	3.0	1.0	2.0	4.0	5.0	3.0	1.0	3.3	2.0	2.0	2.0	1.0	1.8
PD5-SKD-O3	2.0	3.0	2.0	1.0	2.0	2.0	5.0	3.0	2.0	3.0	3.0	2.0	2.0	2.0	2.3
PD5-PMK-F1	1.0	2.0	3.0	2.0	2.0	4.0	2.0	2.0	3.0	2.8	3.0	2.0	3.0	2.0	2.5
PD5-PMK-R1	2.0	2.0	2.0	2.0	2.0	2.0	5.0	2.0	2.0	2.8	2.0	3.0	2.0	2.0	2.3
PD5-PMK-L1	1.0	2.0	3.0	1.0	1.8	3.0	5.0	4.0	2.0	3.5	2.0	3.0	2.0	2.0	2.3
PD5-PMK-O1	2.0	3.0	2.0	2.0	2.3	2.0	5.0	2.0	2.0	2.8	3.0	2.0	4.0	2.0	2.8
PD5-F-F1	1.0	2.0	1.0	1.0	1.3	4.0	5.0	5.0	4.0	4.5	2.0	1.0	4.0	2.0	2.3
PD5-F-I1	1.0	2.0	3.0	1.0	1.8	2.0	5.0	2.0	2.0	2.8	2.0	1.0	3.0	2.0	2.0
PD5-F-O1	2.0	3.0	3.0	2.0	2.5	2.0	5.0	3.0	2.0	3.0	3.0	4.0	3.0	2.0	3.0
PD5-MC-F1	1.0	4.0	3.0	2.0	2.5	5.0	4.0	4.0	3.0	4.0	3.0	3.0	2.0	2.0	2.5
PD5-MC-I1	2.0	2.0	2.0	1.0	1.8	3.0	4.0	3.0	3.0	3.3	2.0	2.0	3.0	2.0	2.3
PD5-MC-I2	1.0	2.0	2.0	1.0	1.5	4.0	4.0	3.0	3.0	3.5	2.0	2.0	3.0	2.0	2.3
PD5-MC-R1	2.0	3.0	2.0	2.0	2.3	3.0	1.0	2.0	2.0	2.0	3.0	3.0	4.0	2.0	3.0
PD5-MC-L1	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.0	2.5	1.0	3.0	2.0	2.0	2.0

PD5-MC-O1	2.0	3.0	3.0	2.0	2.5	2.0	5.0	2.0	2.0	2.8	3.0	2.0	3.0	2.0	2.5
PD5-OSP-F1	2.0	1.0	3.0	2.0	2.0	5.0	1.0	2.0	4.0	3.0	3.0	5.0	4.0	2.0	3.5
PD5-OSP-O1	2.0	3.0	3.0	2.0	2.5	2.0	5.0	2.0	2.0	2.8	3.0	5.0	3.0	2.0	3.3
PD5-LO-F1	3.0	1.0	2.0	2.0	2.0	2.0	1.0	2.0	3.0	2.0	2.0	5.0	3.0	3.0	3.3
PD5-LO-O1	2.0	3.0	2.0	2.0	2.3	2.0	5.0	2.0	2.0	2.8	3.0	4.0	3.0	2.0	3.0
Average	*1.8*	*2.5*	*2.3*	*1.7*	*2.1*	*3.2*	*3.5*	*2.6*	*2.8*	*3.0*	*2.5*	*3.0*	*3.0*	*2.2*	*2.7*

E. WORST-CASE SCENARIO

From Appendix E we conclude that for some risks the scores of the individual experts vary significantly. We therefore are interested what would happen if we took the most pessimistic risk view per risk. In that manner we investigate a worst-case scenario. In practice that means that for the worse case Risk Score for a certain risk *i* we take the maximum of $P_{ij} * I_{ij}$ for all experts *j.* We obtain the worst-case RPN in the same manner. In the following sections we perform the same analyses as we did on the average scores in Section 5.3.2.

Total Aggregated risks in the worst-case scenario

Table E.1: Total risks per situation and total aggregated risk per role per situation

Role	Risk score KD Rotterdam project	RPN KD Rotterdam project	Risk score 1st KD product	RPN first KD product	Score 5th-10th KD product	RPN 5th-10th KD product
Policy maker	10	40	10	40	10	40
Supplier of permission	10	30	10	30	10	30
Owner substructure	24	96	24	88	24	88
Designer of the appearance	70	140				
Designer of the construction	114	267				
Other advisors	45	91				
Project developer	131	343				
Supplier of the KD product			284	821	281	745
Project manager with local market knowledge			52	120	52	108
Financer	60	193	33	104	40	98
Main contractor	82	138	58	162	66	150
Owner superstructure	35	78	25	60	30	105
Land owner	29	78	21	78	24	78
Project/product total	610	1494	517	1503	537	1442

From Table E.1 we draw several conclusions on the worst-case scenario. First of all we see that the Risk Scores decrease if we compare the project situation with the product situation. However, contrary to the average scenario we see that a slight increase in total Risk Score if we compare the 1st KD product situation with the 5th-10th KD product situation. Secondly, we obtain that the total RPN stays more or less the same if we compare the project situation and the 1st KD product situation. If we compare those RPN scores to the 5th-10th KD product

situation we see a slight decrease. Compared to the scenario in which analyzed the average score we can say that in a worst-case scenario the total risk does not decrease as clear as in the average scenario.

Finally we can conclude that the *Financer* and the *Main contractor* roles benefit the most in terms of total risk amount carried from turning the project into a product. In terms of RPN those roles benefit also from replicating the product. The latter also counts for the *supplier of the Karel Doorman* role. In terms of Risk Score the benefit of replicating the product does not become clear. The benefit therefore must lie in the manageability. In the average scenario we see a significant decrease in amount of risk (both in Risk Score and RPN) due to replicating the product, that effect is less clear in the worst-case scenario.

In the average scenario we saw that the largest amount of risk was carried by respectively *the project developer* and *the supplier of the Karel Doorman*. This is still the case in the worst-case scenario.

Individual risks in the worst-case scenario

For the worst-case scenario we determined the major risks as well. We used the same criteria (Risk Score ≥ 9, RPN ≥25) to make a fair comparison.

Table E.2: Worst-case scenario risks with a Risk Score higher than or equal to 9 in the Karel Doorman Rotterdam project situation

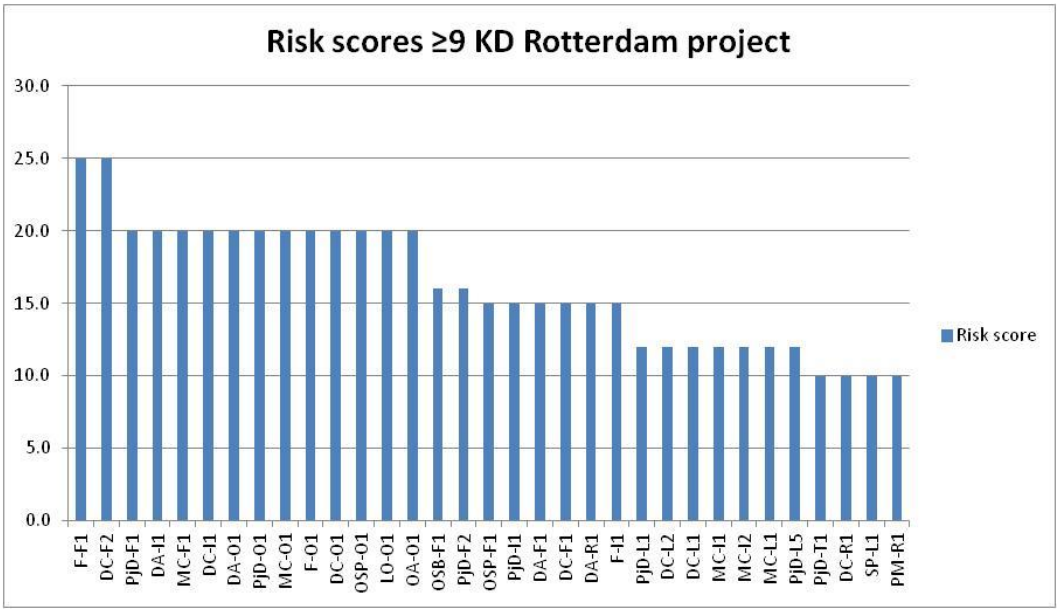


Table E.3: Worst-case scenario risks with a RPN higher than or equal to 25 in the Karel Doorman Rotterdam project situation

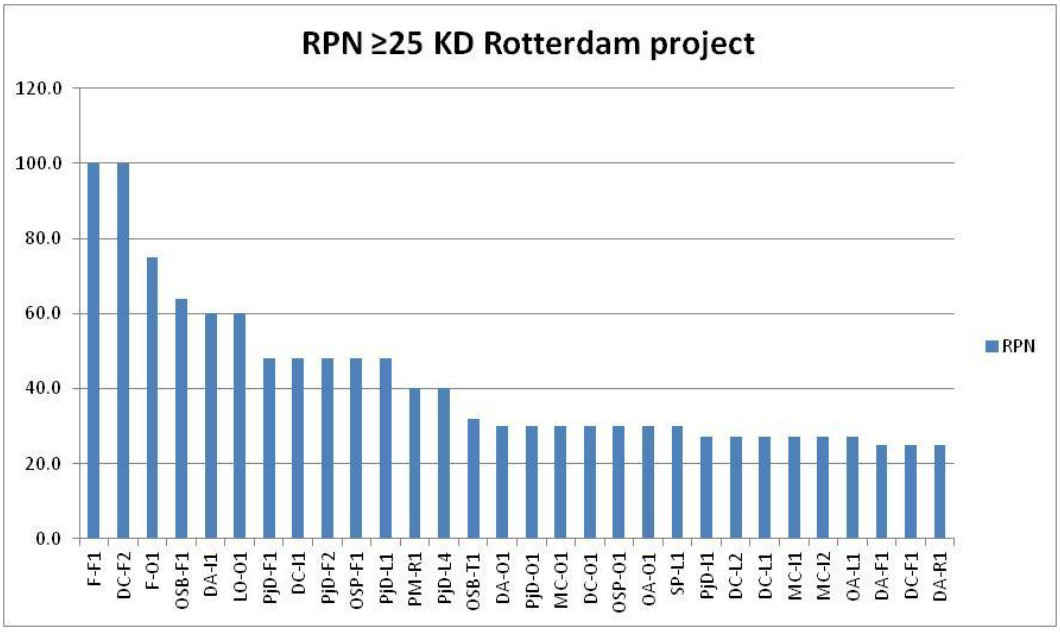
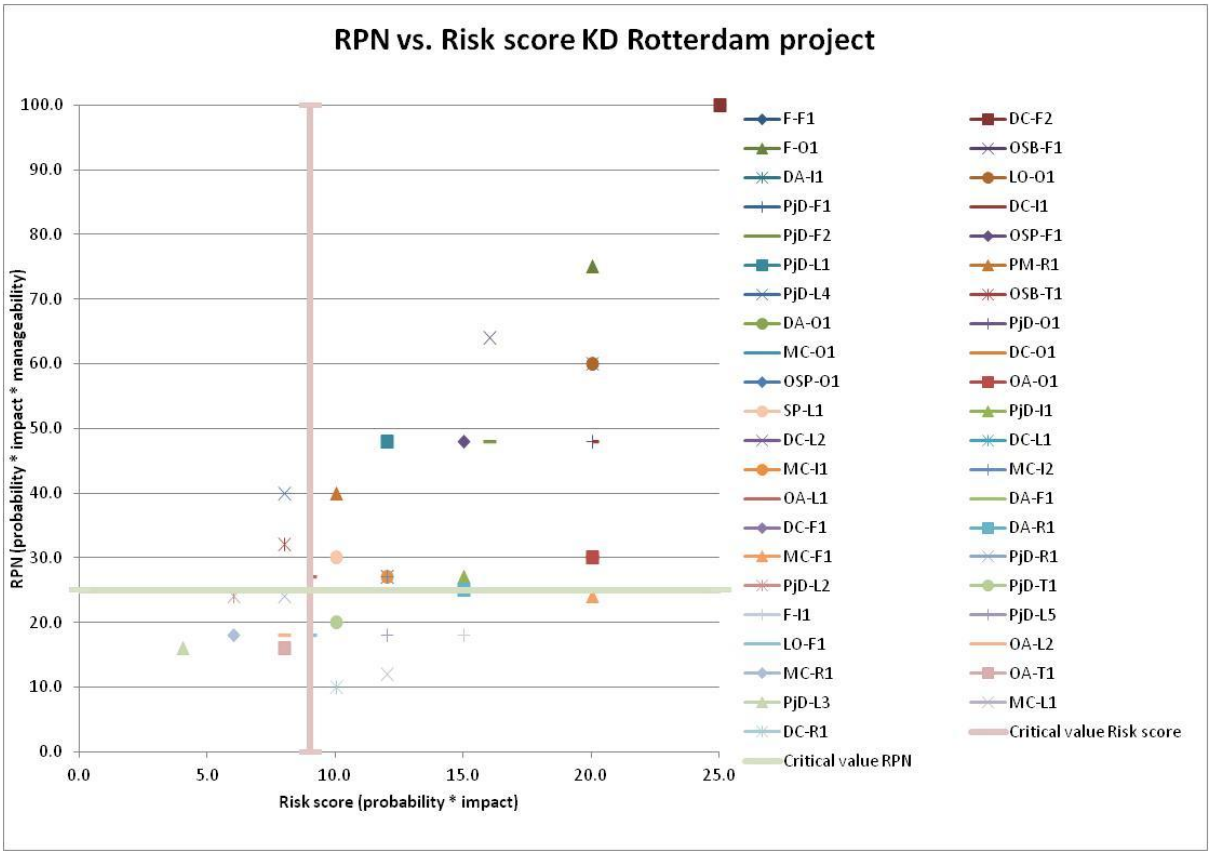


Table E.4: RPN versus Risk score for worst-case scenario risks in the Karel Doorman Rotterdam project situation



From Tables E.2, E.3, and E.4 we conclude that there are 35 risks with a Risk Score ≥9, 33 risks with a RPN≥25, and 28 risks that are critical in the worst-case scenario of the KD

Rotterdam project situation. Compared to the average scenario in which we indentified only 8 major risks, we see a large increase in the amount of major risks (+312%).

Table E.5: Worst-case scenario risks with a Risk Score higher than or equal to 9 in the 1st KD like product situation

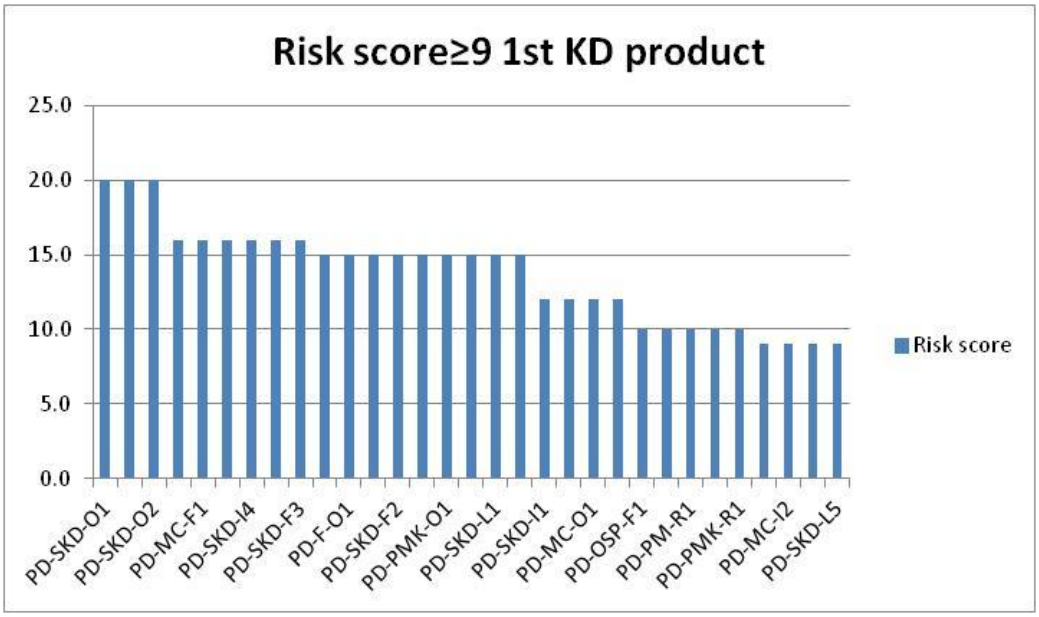


Table E.6: Worst-case scenario risks with a RPN higher than or equal to 25 in the 1st KD like product situation

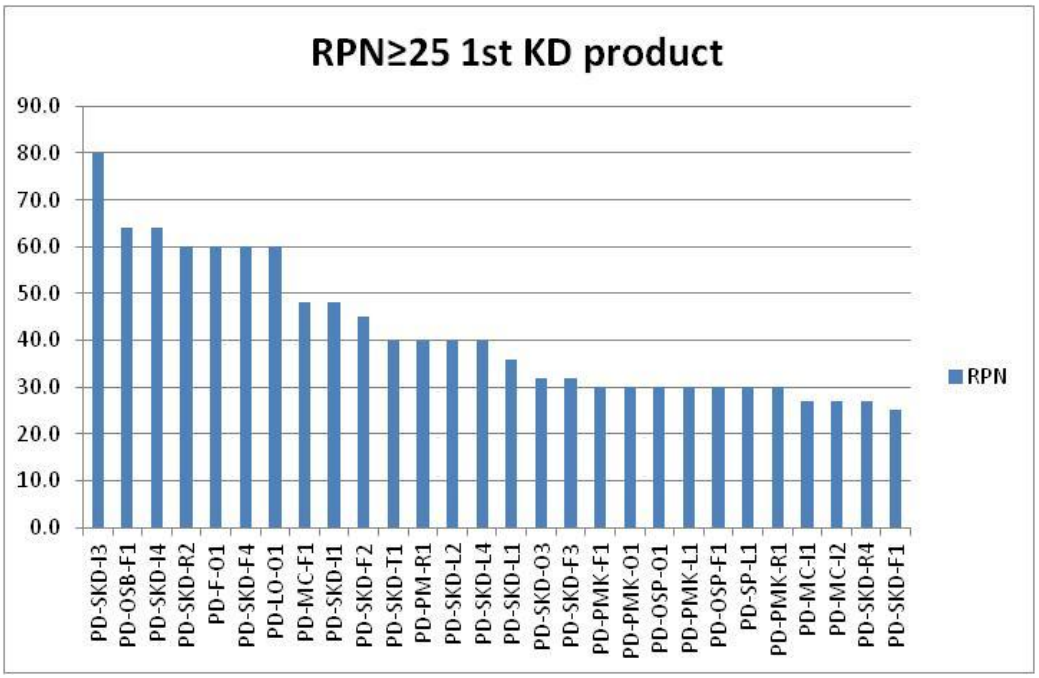
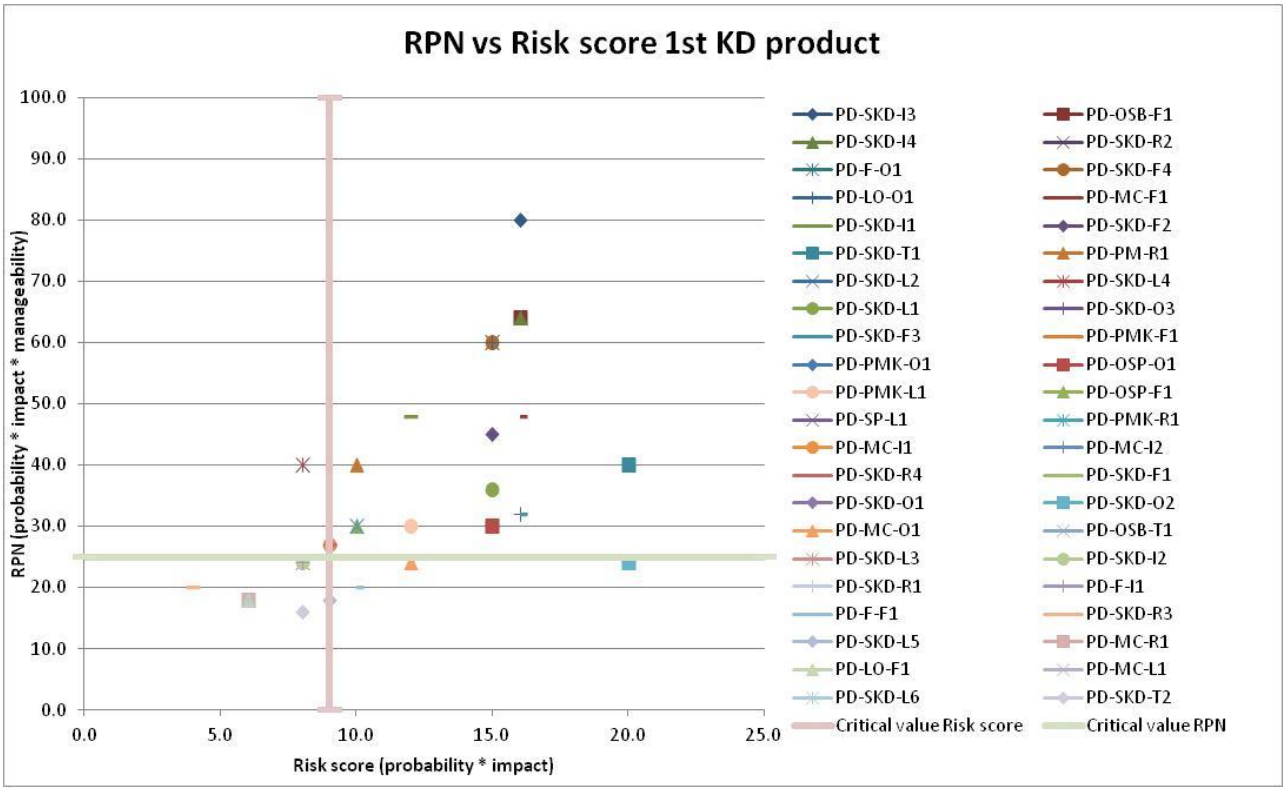


Table E.7: RPN versus Risk score for worst-case scenario risks in the 1st KD like product situation



From Tables E.5, E.6, and E.7 we obtain that there are 31 risks with a Risk score≥9, 28 risks≥25, and 26 major risks in the worse-scenario for the 1st KD like product situation. Compared to the KD Rotterdam project situation we see a small decrease in the amount of major risks. Furthermore we can see that the major risks are moving towards the intersection of the lines that indicate the critical values for the Risk Score and RPN.

Finally we conclude that there is a significant increase in the amount of major risks if we compare the worst-case scenario (26 major risks) with the average scenario (10 major risk). That is an increase of 160%.

Table E.8: Worst-case scenario risks with a Risk Score higher than or equal to 9 in the 5th-10th KD like product situation

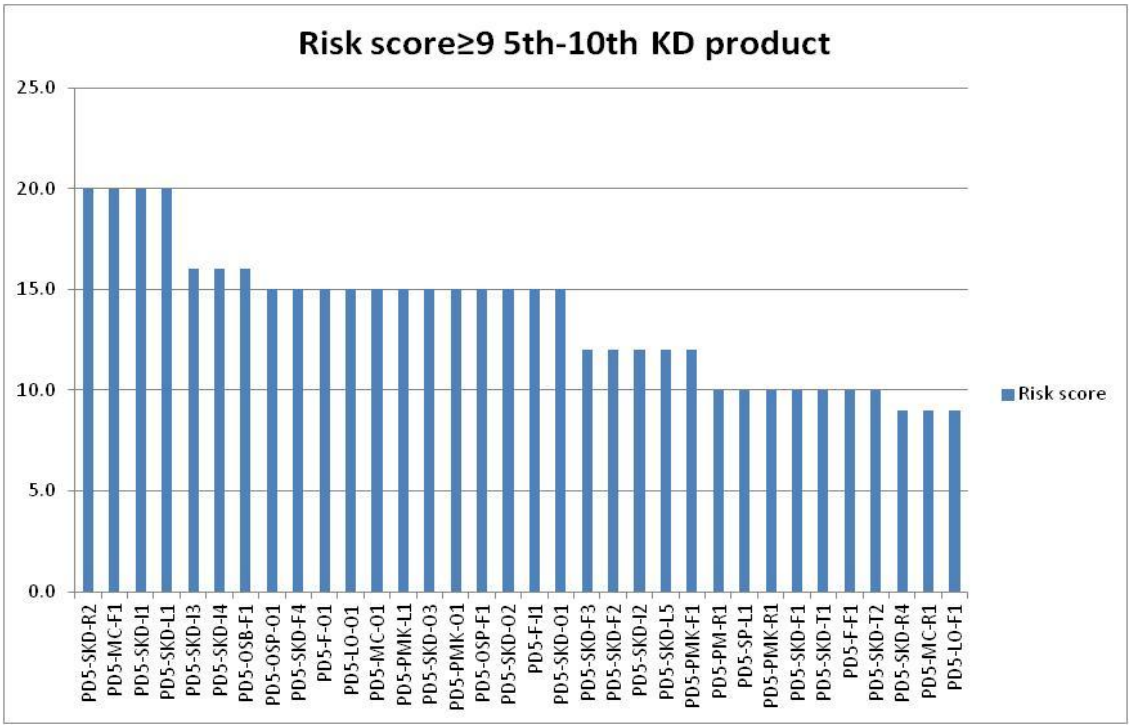


Table E.9: Worst-case scenario risks with a RPN higher than or equal to 25 in the 5th-10th KD like product situation

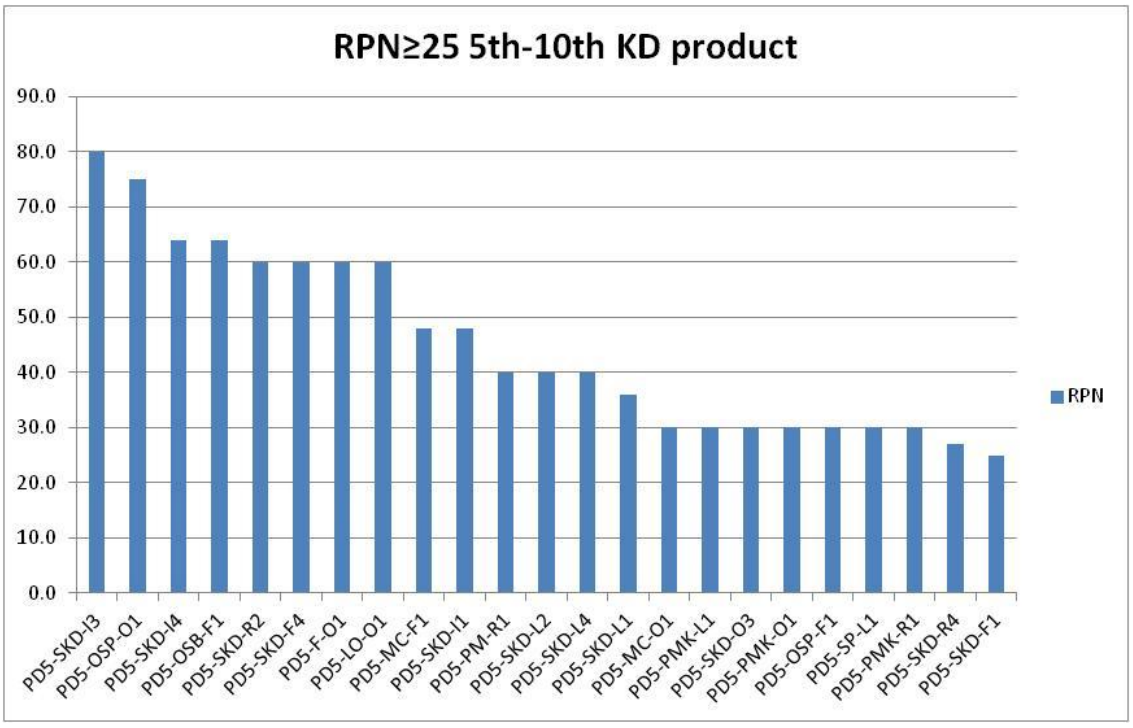
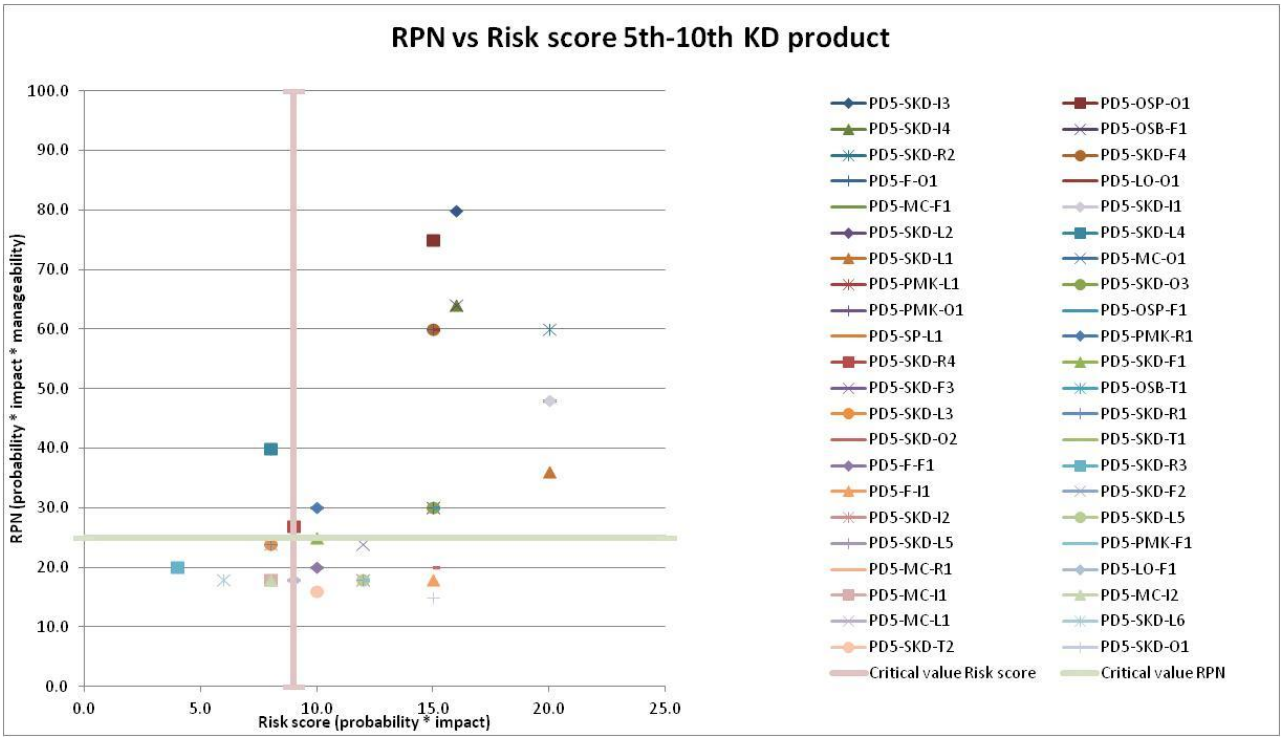


Table E.10: RPN versus Risk score for worst-case scenario risks in the 5th-10th KD like product situation



From Table E.8, Table E.9, and Table E.10 we obtain that there are 34 risks with Risk Score≥9, 23 risks with RPN≥25, 21 major risks in the worst-case scenario for the 5th- 10th KD product situation. The amount of major risks decreased if we compare this to the two other situations.

Furthermore, we conclude that there is a significant increase in the amount of major risks if we compare the worst-case scenario (21 major risks) with the average scenario (3 major risks). That is an increase of 700%.

Our final conclusion from the worst-case scenario analyses of the individual risks is that there is a significant difference in amount of major risks compared to the average scenario. The conclusion from our average scenario analysis that replicating the product leads to less major risks is still valid in the worse –case scenario. From the worst-case scenario we could even conclude that turning the KD Rotterdam project into (the first) KD product leads to a slight decrease in major risks.

Table E.11: Overview of risks carried by NSI roles

	KD Rotterdam project	1st KD product	5th-10th KD product
Role	Designer of the construction	Supplier of the KD product	Supplier of the KD product
Amount of risks carried	7	23	23
Aggregated total risk (risk score; RPN)	(114;267)	(284;821)	(281;745)
Amount of major risks carried	6	12	9
Largest Risks carried (risk score; RPN)	DC-F2 (**25**; **100**)	PD-SKD-T1 (**20**; 40) PD-SKD-I3 (16; **80**)	PD5-SKD-I1 (**20**; 48) PD5-SKD-I3 (16; **80**)

From the table above we see that the NSI (Royal HaskoningDHV) carries significantly more risks in the product situations compared to amount of risks in the project situation (from 7 to 23). This is also reflected in the total aggregated risk measured both as risk score and RPN.

Another more remarkable observation is the fact that the amount of major risks doubles when we compare the project situation with the 1st product situation, but the difference between the project situation and 5th-10th product situation in terms of major risks carried is far less severe (from 6 to 9 major risks).

Furthermore we see that the largest risk that has to be carried by NSI (Royal HaskoningDHV) decreases if we compare the project situation with the KD product like situations.

Finally, we conclude that the positive effect (risk reducing) of replicating the product is visible in the worst-case scenario as well. However we see this effect just in the amount of major risks, whereas in the average scenario we see this positive effect both in the amount of major risks and the decrease in the largest risks carried.

F. USE OF THE INNOVATION FUNNEL WITHIN NSI

To convert projects into successful products or services, in other words: to innovate, NSI makes use of an Innovation funnel.

This funnel starts with the ideation phase in which NSI searches for ideas/projects/concepts that seem to be interesting for further development by NSI. Most of this input is found within projects of the other business units. In the first screen some ideas are filtered out, others proceed to the feasibility phase in which for example the value proposition and earning logic are investigated and secured.

Some ideas are filtered out after this stage. It could either be the case that a traditional business model is most suitable. In this case the development is done by another, relevant business unit. Another option is that the conclusion is that there is no suitable business model for this idea, at least not within Royal HaskoningDHV. These ideas are filtered out as well. We suggest that in the end of this phase the value network should be taken in to consideration as well by applying the RRBS. If the value network (in terms of roles and risk) is unbeneficial these ideas could be filter out as well. Or the value network can be decisive in which idea to develop first.

The other ideas can be seen as a product or service now. The third phase is the development and innovation phase in which NSI tries to find a launching customer and other leads for the ideas that have been transformed into a product or service. If the product or service is realized for the first time this product or service proceeds to the roll out phase. If no launching customer or concrete lead can be found the product or service is filtered out. If a product or service reaches the roll out phase, this can be seen as a successful innovation of turning a project in to a product/service by NSI.

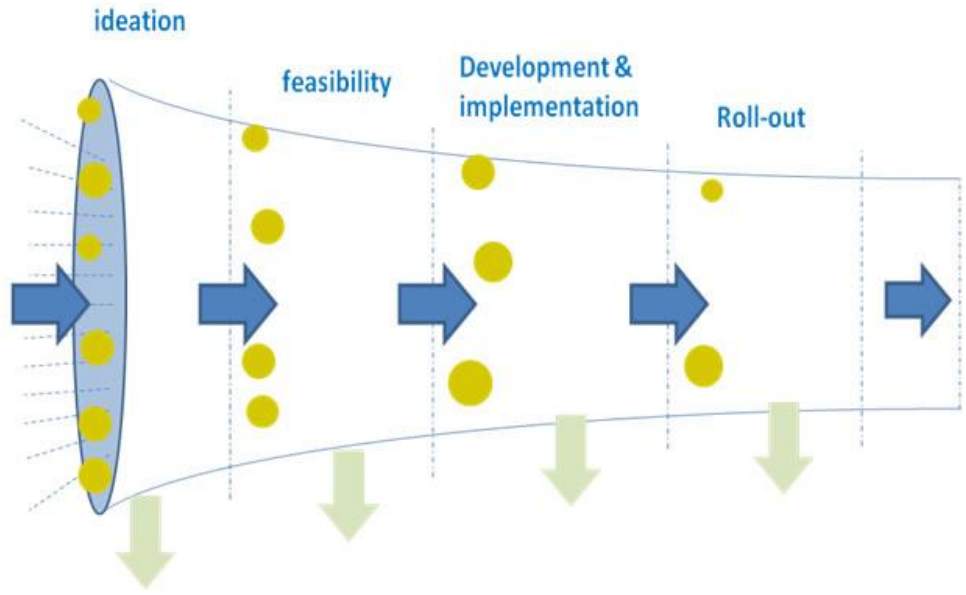


Figure F.1 The innovation funnel