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# Risk Management in Residential Construction

*An analysis of the risk management process of a Swedish construction company*

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ROYAL INSTITUTE OF TECHNOLOGY

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT

# Master of Science Thesis

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## Abstract

Risk can be described as the absence of information when a decision is to be made at any time throughout a process. The construction industry is often considered as complex and defragmented due to working in a project based format; with a unique product and a process where there are times when decisions need to be made with insufficient information. Therefore, proper risk management processes can be vital to minimizing risks, maximizing opportunities and securing a successful project process.

This master thesis has been conducted at a large Swedish construction company that houses both a constructing unit and a residential development unit. Consequently, the focus of this thesis has been on analyzing the risk management process when a residential project is both developed and constructed by the same company.

The purpose of this master thesis is to describe and analyze risk management in a project based organization within the construction industry. The thesis aims to provide a better understanding of how risk management is used in practice but also what underlying factors that can affect risk management processes. The study will include both the perspective of the developer and the constructor; as well as their separate and joint processes facilitating risk management.

In regards to the purpose of this thesis, a general risk management model has been used to provide a framework for analysis. This model consists of four steps: risk identification, risk assessment, risk mitigation and risk monitoring.

The results from this study indicate that risk management within residential construction heavily depends on the personal knowledge and experience of project members. In turn, this creates discrepancies between how risk management is described in internal documents and how it is utilized in practice. Furthermore, it was found that risk management is considered an important part of the overall project process. However, opinions varied to what extent risk management was actually applied in projects. A reason for this could be that there is no joint understanding within the company of what processes are considered as part of risk management – thus, project members sometimes practice risk management without being aware of it.

# Examensarbete

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Titel	Risk Management in Residential Construction – An analysis of the risk management process of a Swedish construction company
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Institution	Real Estate and Construction Management TRITA-FOB-ByF_PrK-MASTER-2016:38
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## Sammanfattning

Risk kan definieras som avsaknaden av information när ett beslut måste tas, vid något tillfälle, under en pågående process. Byggindustrin anses ofta vara en komplex och splittrad bransch då man arbetar i projektformat och med en komplicerad slutprodukt, vilket skapar otaliga tillfällen när beslut måste fattas med otillräcklig information. Därför är en väl fungerande riskhanteringsprocess viktig för att minimera risker, maximera möjligheter och säkerställa lyckade projekt.

Detta examensarbete har genomförts på ett av de större svenska byggbolagen som har både bostadsutveckling och entreprenad inom den egna verksamheten. Därmed kommer detta examensarbete att fokusera på riskhanteringsprocessen inom bostadsbyggande då ett och samma företag agerar som både beställare och byggare.

Syftet med detta examensarbete är att beskriva och analysera riskhanteringsprocessen inom ett projektbaserat företag i byggbranschen. Uppsatsen har som mål att skapa en bättre förståelse för hur riskhantering används i praktiken, samt för de underliggande faktorer som påverkar riskhantering. Studien kommer att inkludera både beställarens och byggarens perspektiv, samt deras respektive, och gemensamma, processer i relation till riskhantering.

Med hänseende till studiens syfte har en generell modell för riskhantering använts för att ge ett ramverk till analysen. Denna modell består av fyra steg: riskidentifiering, riskvärdering, riskhantering och riskuppföljning.

Studien visar på att riskhantering inom bostadsbyggande till stor del grundar sig på projektmedlemmarnas personliga kunskap och erfarenhet. Detta leder till att det finns skillnader mellan den avsedda processen för riskhantering och hur riskhanteringsarbetet faktiskt genomförs. Vidare fann studien att riskhantering ansågs vara en viktig del av projektprocessen i sin helhet. Trots detta varierade åsikter kring hur riskhantering faktiskt genomfördes i projekt. En anledning till detta kan vara att det inte finns någon gemensam syn på vilka processer som faktiskt ingår i riskhanteringsarbetet – detta innebär i sin tur att projektmedlemmar ibland bedriver riskhantering utan att vara medvetna om det.

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We would like to express our deepest and warmest gratitude to the company that has hosted us during the spring of 2016 and all of those who have taken the time to partake in this study and helped us forward to new insights. In order to keep both the respondents and the company anonymous, we won't mention any names. But, as a rough translation of the Swedish saying, goes; "None named, none forgotten".

Furthermore, we would like to sincerely thank our supervisor at the Royal Institute of Technology, Tina Karrbom Gustavsson – for always inspiring us and challenging us to think in new ways. Your valuable advice has helped us tremendously!

Stockholm, May 2016

Johan Bonander & Hampus Ulriksson

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# 1. Introduction

*The purpose of this chapter is to form the outline for this master thesis. The chapter will provide a background to the research, followed by purpose and delimitations.*

## 1.1 Background

The construction industry is often described as defragmented and complex (Osipova, 2015) due to working in a project based format. Within the construction industry, the organization is often small in the early stages and grows throughout the acquisition-, design- and production process. After the goal is achieved and the project is completed, the organization disbands. Within the residential development business, only a small group of individuals from the developer and contractor are left behind to handle any warranty issues. The complexity in the project stems from the final result, where a unique product is constructed to suit the client's needs. The uniqueness of the product and the defragmented work process creates for uncertainties. These uncertainties appear as either risks or opportunities throughout the project life cycle.

There are numerous reasons for which uncertainties might appear during a project. Generally, these can be related to either organizational or mechanical conditions. Organizational uncertainties could stem from the alterations in the project group throughout the project timeframe. Moreover, project members can be individuals with quite different backgrounds, experiences and opinions. Mechanical uncertainties, however, are related to the scope and requirements related to a specific site. Regardless if such uncertainties can be forecasted or not, they could pose a significant risk to the project itself.

Risk is generally a term used to describe the exposure to danger, the possibility of loss or a potential hazard. The term can be altered and used in a wide variety of aspects, depending on the topic of discussion, even within the construction industry (Akintoye & MacLeod, 1996). The body of academic literature regarding risk management within the construction industry is vast. However, there are uncertainties to what extent the different theories presented on risk management actually work in practice.

Even though each project is unique, the project life cycle of residential development projects is similar between different projects. Therefore, it is of interest to explore how risk management is conducted in practice and the reasons behind the adopted approaches.

## 1.2 Purpose

Risk management is an integral part of conducting a residential construction project (Osipova & Eriksson, 2013). Within research and academic literature, there are numerous

theories that suggest how to successfully identify, assess, and mitigate risks within the construction industry.

Still, there is research showing that even though risk management works in theory, it often fails to be successful in reality (Osipova & Eriksson, 2013). Moreover, there is research showing that the techniques proposed in literature are rarely utilized in reality.

The purpose of this master thesis is to describe and analyze risk management in a project based organization within the construction industry. The thesis aims to provide a better understanding of how risk management is used in practice but also what underlying factors that can affect risk management processes. The study will include both the perspective of the developer and the constructor; as well as their separate and joint processes facilitating risk management.

Since most of the larger construction companies in Sweden have similar processes, the conclusions from this study will hopefully be applicable and helpful to other organizations as well.

### **1.3 Delimitations**

Risk is a concept that can be broadly defined and can be applied in numerous situations. If not mentioned otherwise, the term risk used within this master thesis will refer to an event that might occur throughout the project that would have a direct effect on project outcome. Therefore, this master thesis will not treat risks that could have a negative impact on intellectual property, cause ethic violations or other, similar problems. Environmental risks, such as contamination, will be adhered to since that could cause a monetary impact; in turn, affecting project outcome.

The thesis will only analyze the risk management process of residential development projects where the construction company acts as both developer and contractor. The study will be analyzing a single company in-depth. Therefore, the study will be limited to this company alone; no comparisons will be made to other organizations.

As have been mentioned previously, only risk management in residential development will be analyzed. Even though the development of commercial property is in many aspects similar in regards to work processes, it lies outside of the scope of this study.

In addition to the above, the study is geographically limited to the Swedish market, even though the subject company operates outside of Sweden as well.

## 1.4 Outline

*Chapter 1* provides an introduction to this master thesis. This includes a background to the chosen research topic, as well as a clarification of the purpose. Furthermore, delimitations to the scope of the study are stated in this chapter.

*Chapter 2* gives the reader an introduction to the general process of construction projects. In addition to this, the subject company is described together with a presentation of how it is organized and how it is structured in regards to the construction process.

*Chapter 3* presents the methodology used in this study. First, the overall approach and design of the study is explained. Secondly, the explicit methods used are presented, as well as a description of the actual research process. Lastly, the reliability and validity of the study is discussed in regards to the purpose and aim of this paper.

*Chapter 4* is based on the literature review and presents existing theory and previous studies in the field of risk management, particularly in construction projects. This chapter presents a general model for risk management which will be used when analyzing the data. Furthermore, it also presents theory in related fields of science, such as knowledge management and relationship management.

*Chapter 5* presents the empirics obtained by interviews and observations. The data obtained in the interviews is presented in relation to the risk management model proposed in chapter 4. Moreover, the current risk management process of the company, as well as available tools for risk management, is explained in detail to provide a good perspective on the data obtained in the interviews.

*Chapter 6* contains the analysis and discussion of the empirics presented in the previous chapter. It emphasizes important findings and applies the theory presented in chapter 4.

*Chapter 7* presents the conclusions of the study, as well as provides recommendations for further studies in the subject. This chapter also suggest improvements for the subject company.

## 2. Construction Project Organizations

*This chapter will present the general process of construction projects. Furthermore, it will provide a description of the subject company, its organization in regards to residential development and how this specific company has structured the development process.*

### 2.1 Construction Project Process

A project is an endeavor with a goal to accomplish a predetermined mission in a predetermined timeframe. The mission alters depending on the project owners and what the owners want to achieve. There are two different types of projects, one is goal-seeking and the other is goal-oriented. By definition, a project has both a starting point and a finishing point. Otherwise, it is considered a process, which is a repetitive event with no start or finish (Karrbom Gustavsson & Hallin, 2012).

Within this master thesis a construction *project* will be defined according to the above. However, we will apply the term *process* in order to emphasize the work process that is used by an organization, when conducting a construction project. In the literature, the term *owner* is used as a description of the project owner. Since this master thesis covers residential construction projects, the term *developer* will be used instead as it is more accurately describing the contractual relations between the parties involved.

Within the residential construction industry, projects are to be considered goal-oriented. Residential developers have a predetermined goal to produce a set amount of units during a set amount of time. Furthermore, since construction projects can be viewed as a linear process, with a start- and finish date, the ability to impact the product gets more and more difficult throughout the duration of the project. The correlation between time and alternation costs is shown in the figure below.

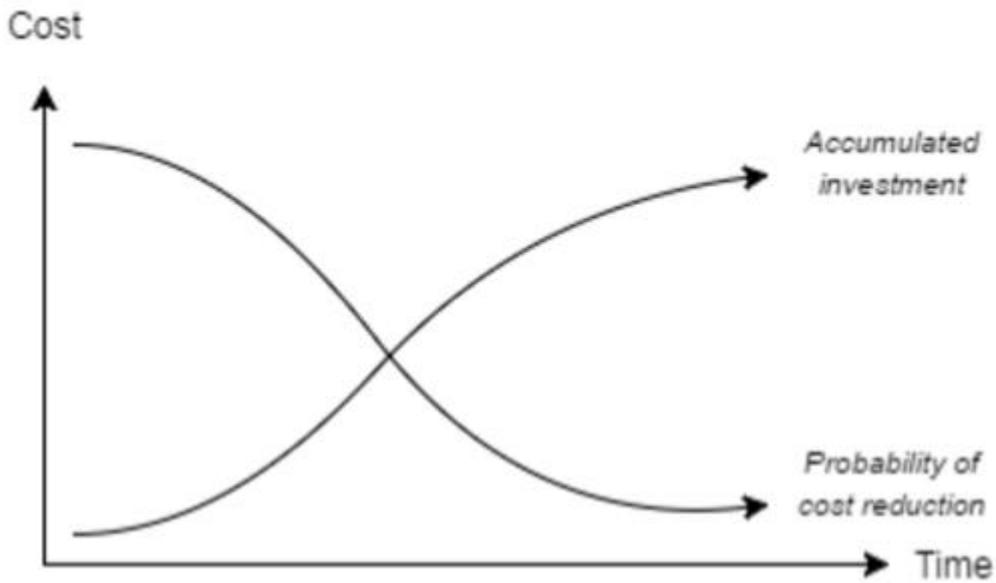


Figure 1 Graph of percentage cost over time; Demonstrating how early decisions affect the possibilities of cost reduction. Adapted from Antunez & Gonzalez (2015)

During the earliest stages of project development, when the concept is decided during the feasibility study, decision made by a project group has the largest impact at a minimal cost. However, if changes are to be made once a project reaches a later stage the possibility to save costs are much smaller. Therefore, it should be important for the project group to have a clear vision from the very beginning to avoid such an increase in cost.

The construction process is divided in two different steps. The first step consists of a development process where the developer defines the project to adhere to any demands set by the municipality in the detailed planning process. The second step is the design- and construction process that produces the project according to the predetermined demands in step one. The figure below shows the different activities that occur when conducting a residential construction project.

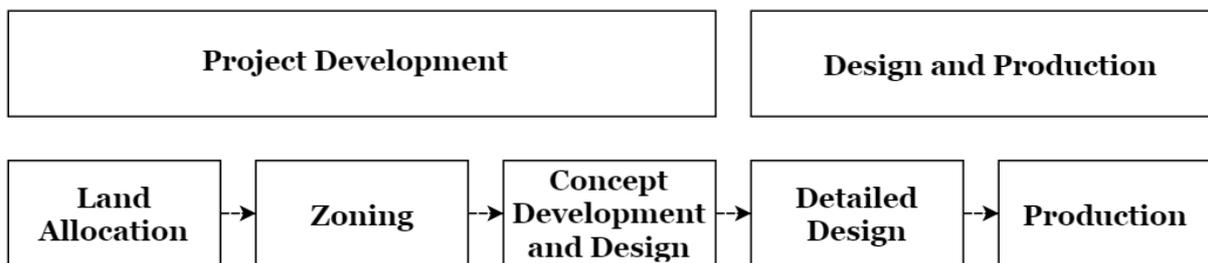


Figure 2 Construction project process adapted from Winch (2010)

### **2.1.1 Land Allocation**

Before a construction project starts, a developer conducts an investment analysis to determine whether or not they perceive the investment as successful. During the initial stages, the developer performs investigations regarding soil conditions, environmental conditions and other external factors that can have an impact on the project. Land allocation in Sweden is usually performed in one of two ways. Either the land is allocated via a purchase or via a land allocation process if the land is owned by the municipality. If the land is allocated via a purchase, the developer conducts due diligence to gather all available information. The other option to allocated land is through a land allocation process conducted by the municipality. In that case, the land allocation can be directly appointed to a single developer, otherwise several developers will be able to compete for the land allocation. Regardless of how the land is allocated, the project moves to the next phase.

### **2.1.2 Zoning**

The zoning process is the legislative procedure required to alter the attributes of specific properties. These attributes decide building criteria, such as amount of floors, the purpose or usage of buildings, as well as where on site the buildings should be located. The municipality also uses the detailed plan to ensure that the architectural plans for the property adhere to the overall architectural tone of surrounding buildings. The legislative procedure is initiated and conducted by the municipality. However, the municipality often involve property owners and developers in order to get their viewpoint on the matter. The next step for a developer depends on the detailed plan for a specific piece of property. If the detailed plan allows for a developer to produce buildings according to the developers plans and needs, the developer can proceed to the next step and start developing a concept for the project. If the detailed plan needs to be altered, the developer has to wait for the municipality to initiate a zoning process. Even though they have to wait for the zoning process to be completed, many developers start with concept development in advance in order to shorten the process.

### **2.1.3 Concept Development and Design**

Once the detailed plan has been approved, the developer can finalize the concept for the project. Regardless of the zoning process, developers often hire architects to start the concept development process in earlier stages of the work process. Once the detailed plan is approved, the developer can finalize the concept and decide on a design. Then, the architect transfers the architectural drawings to design drawings. In this phase, the project team grows as more consultants are hired. As the architectural design phase reaches its end,

the project becomes more detailed as more installations are designed. Once the project reaches the end of this phase, the scope is finalized.

#### **2.1.4 Detailed Design**

When the project reaches the detailed design stage, the concept has previously been decided and the scope of the project is finalized. During the detailed design stage, the design documents are transferred into building documents used by the contractor. The first step for the developer, when entering this stage, is to decide on the contractual form they intend to engage with the contractor. The two most common contractual forms are design-build and design-bid-build. In a design-build contract, the contractor is the one responsible for the detailed design stage since the developer have purchased a solution rather than purchasing a predetermined product. If it is a design-bid-build contract, the developer is responsible for providing the detailed drawings in the scope and then the contractor will build the product according to the developer's drawings.

#### **2.1.5 Production**

The final step in the construction process is the production stage. When entering this stage, more project members have been recruited as all production personnel are engaged in the project. During this stage, the contractor has the main responsibility to provide the project according to the predetermined scope. At this time there are none or small possibilities to alter the project as it increases the risk of delays and an increase in costs. Even if the contractor is the one responsible for the production, the developer still has obligations to both the project owner (if built for one), and also towards the municipality. In reality, many of the different responsibilities designated towards the developer are transferred to the contractor; the contractor is often the party best suited to carry responsibilities regarding construction.

## **2.2 The Subject Company**

### **2.2.1 The Subject Company Organization**

The company where the research is conducted is one of Sweden's larger construction companies. The company consists of different in-house development units and construction units.

The organization of residential development is divided in four different regions: Stockholm, Gothenburg, Öresund and Riks (rest of Sweden). Each region has a regional manager with the overall responsibility. The rest of the organization is divided in three departments that all have different responsibilities throughout the acquisition-, design-, and production process. Apart from the three main departments each region has support functions.

The business development department consists of surveyors, business developers, property managers and a department manager. This is the unit responsible for finding potential projects, manage the land bank of property owned by the company and manage relations with the municipality and property owners.

The project development department consists of project developers, real estate economists and project development managers.

The contractor is divided into different regions as well. Besides being divided based on geography, they are also divided based on their core competence, where some districts are specialized in residential construction. Apart from the supportive functions, the region is divided into districts led by a district manager. Different districts are divided between rebuilding and new building development. They also have a business unit that operates in the earliest stages of a project where they can use their production competence to assist the developer.

After the development is completed, the project group gathers all the documentation about the project and engages the after-market department. The after-market department consists of a department manager together with project managers and customer service representatives. They are engaged once the production reaches its completion and are responsible to handle any warranty issues. They also have the responsibility carry the project through the last tollgate and gather the knowledge created throughout the entire project process.

### **2.2.2 The Subject Company's Construction Process**

Residential projects developed and constructed in-house follow a given work process similar to the one explained in chapter 2.1. They work with a process consisting of tollgates where a project is divided into seven different phases, shown in the figure below. Before a project can continue past a tollgate, a Request for Investment (RFI) is sent to the governing body. The RFI covers key figures, project description, intended target market, revenue calculation and potential risks and opportunities. The company's construction process is similar to *figure 2*. The figure below shows how the construction process is described within the company.

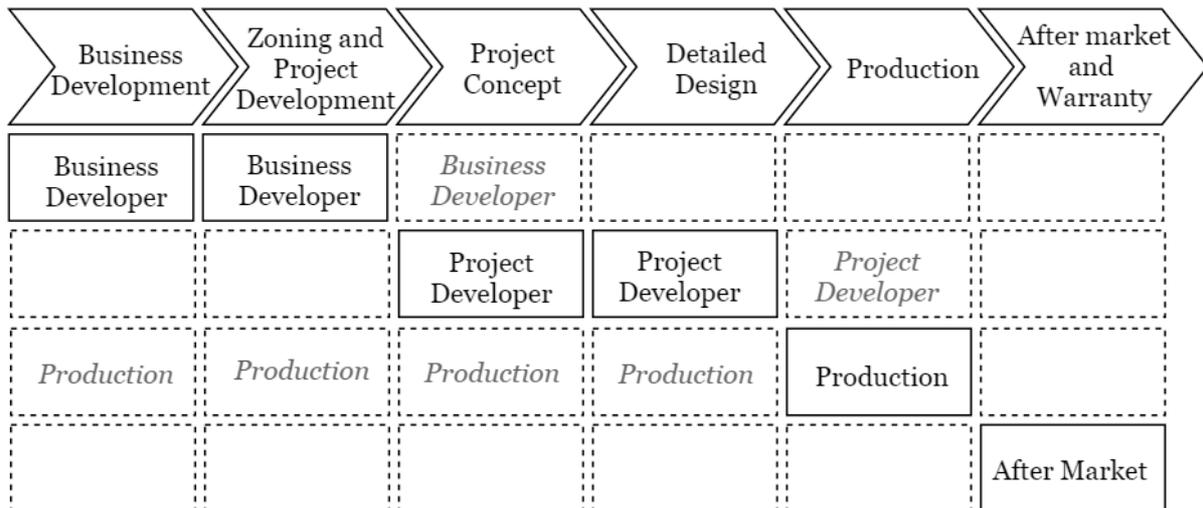


Figure 3 Areas of responsibility during a project (Author's own adaptation of internal documents)

The difference is that there is an additional stage as the aftermarket and warranty step is added the process. However, the largest difference is that there are larger collaborative elements included in the company's construction process. The project member highlighted shows which member that has the main responsibility over a given step in the process. The *gray* title show to where a specific unit assist the responsible unit in the process.

The initial step is to form a project mission to start a project. This sets the framework for the project to ensure it adheres to the strategy and business plan. The business development unit is the one responsible for this step as well as the second one. How to proceed differs; in case land is allocated from a private property owner, they do the due diligence needed to finalize the terms of the purchase. Alongside they collaborate with the municipality and define a concept for a development that adheres to the municipalities demand. Parallel to this, the legislation process continues to finalize on a detailed plan and the business development department continues to develop the project. They engage consultants and the contractor to finalize a concept and to produce construction estimations. The business development unit has the main responsibility in the first two steps of the production process. During these steps, they finalize the design concept for the project and scope for the project. Since the contractor is engaged in the initial steps of a project they can submit a tender based on the early construction documents. At the end of the second step they start to engage the project development department.

Once the second tollgate is passed, the project is transferred to the project development unit. This is done via a hand-over meeting where the business development unit hands over the scope, tenders, drawings and related information. The project developer has the main responsibility to ensure that the projects can proceed through the project process. As the project proceeds through the tollgates, the project group will grow as more project members are engaged. The project becomes more detailed as the design stage prolongs.

During this stage, a finalized tender is submitted from the contractor and a design-build contract is signed by the parties.

Once the project reaches the production phase, the contractor is the unit with the main responsibility to lead the process. During the production phase, the project developer from the development side serve as the owner representative and the project manager from the contractor serve as the contractor representative. They collaborate together through the construction process to ensure that the project meets predetermined requirements acknowledged in the project scope. They also need to ensure that the project meets all the legal requirements and building norms decided by the authorities.

When production is completed and the building inspector has left a final approval, the project is considered to be done. Then, the project responsibilities are transferred via a handover-meeting from the project developer and the contractor to their respective after-market units. All necessary documents are handed over and the after-market unit handles any warranty issues that could occur.

### **3. Methodology**

*In this chapter, the chosen research methodology will be presented and explained in order to provide the reader with a better understanding of the framework for this study. The methodology includes the overall approach and design of the research, as well as the explicit methods used. Furthermore, the suitability of these research methods will be discussed in regards to the aim and purpose of the paper.*

#### **3.1 Research Approach**

The application of theory in research can be managed in different ways; the most common of these are known as the deductive approach and the inductive approach. While the deductive approach develops a theory that is then tested through research, the inductive approach uses data collection in order to develop a theory from the results. (Saunders, et al., 2009)

However, there is another concept that combines both of these approaches; the abductive approach. Abduction is similar to induction in the sense that it starts with empiricism, however, it still takes theory into account in a manner that is similar to deduction. (Dubois & Gadde, 2002)

The main approach adopted by this paper is the abductive one. Doing so, the research scope will be developed throughout the research process and any new insights gained allows for alterations of the theoretical framework that is used.

#### **3.2 Research Design**

A research design can be characterized as exploratory, explanatory or descriptive. However, in some cases, the research design will be multifaceted and have more than one of the previous characteristics. (Saunders, et al., 2009)

The nature of this paper can best be compared with an exploratory study; it seeks to clarify an understanding of a problem that is, to some extent, imprecise. The advantage to exploratory studies is the flexibility to change direction depending on the findings of new data or insights. Although the focus might be broad at an early stage it becomes narrower over the course of the research. This study will utilize some of the principal methods for collecting data in exploratory research; literature studies and interviews with professionals in the subject. (Saunders, et al., 2009)

#### **3.3 Research Strategy**

As have been mentioned previously, this paper is written in collaboration with a construction company. One of the authors of this paper is, at the time of writing, employed

by the same company, thus undertaking the role of being a practitioner-researcher. Such a role creates for both advantages and threats to the research itself. For instance, having previous knowledge of the company minimizes the time needed to grasp the organizational context, in comparison to someone who is unfamiliar with the specific company. On the other hand, such previous knowledge might create bias in the form of assumptions and preconceptions. Bias of that kind might prevent exploration of areas that would otherwise have been beneficial to the research. (Saunders, et al., 2009) The authors of this paper are well aware of the problem this poses and will make every effort to remain objective and unprejudiced throughout the study.

One advantage to the role of a practitioner-researcher is the question of access. Being a part of the organization should most likely ease the process of getting access to potential interviewees, as compared to external researchers. Furthermore, the practitioner-researcher will be able to make observations of actual behavior; in contrast to what is only stated in an interview setting. Since the research is mainly conducted at the headquarters of the company, the authors will be able to make such observations in a natural environment. In the event that such observations will be made in relevance to the aim and purpose of the paper, they will be presented in the empirical findings and discussed in the analysis.

### **3.4 Methods**

Methods refer to the different techniques used to collect and interpret data. Such methods are commonly categorized as either quantitative or qualitative. The term quantitative refers to numerical data. Respectively, the term qualitative refers to non-numerical data. (Saunders, et al., 2009)

As previously mentioned, this study is of an exploratory nature; thus, it will most likely benefit from using qualitative methods that enables the finding of new aspects and insights (Saunders, et al., 2009). The qualitative method, in this case, primarily consists of in-depth interviews with professionals in the construction industry. These interviews, coupled with literature studies and analysis of the company's internal documents, form the base of empirics for this paper.

### **3.5 Research Process**

Initially, several interviews were conducted in regards to risk management. This was done as a pre-study, in order to create a foundation for discussion and to identify aspects of risk management that could be further elaborated on. The interviews consisted of open-ended questions in order to allow the interviewees to more freely reflect upon the subject (Saunders, et al., 2009). The interviewees were chosen based upon their involvement in different phases of a project; business developers, project developers, and customer service

agents. The intent behind such a selection was to capture viewpoints from most parties involved in the entire project timeframe; from project design to aftermarket.

Conducting the initial interviews in an unstructured manner enabled exploration of the subject of interest, namely risk management in construction projects. Generally, unstructured interviews indicate that there is no list of predetermined questions (Saunders, et al., 2009). However, a set of guideline topics was prepared in advance. Since these interviews were rather non-directive, the respondent was allowed to freely expand on the chosen topics. Given the informal nature of unstructured interviews, the data obtained was recorded by note taking throughout the interviews.

Thereafter, the research focused on finding a suitable angle and delimitation in the subject of risk management in residential construction. Several ideas were formed and discussed until a general direction was established. Consequently, literature studies had to be made in order to find existing theories on risk management that could be applied to project organizations in the construction industry.

Having done an extensive literature study enabled a second round of semi-structured interviews. As for the later round of interviews being semi-structured, this also goes in line with qualitative research (Saunders, et al., 2009). A set of themes with subsequent questions were established, albeit adapted to the organizational context of each respondent. Since these interviews were non-standardized, it was deemed suitable to use audio-recordings together with note taking. Primarily due to the fact that note taking would be insufficient in capturing every answer to its full extent, but also since it would enable the interviewers to fully engage in the dialogue. Naturally, audio-recording was only done with the consent of the respondent.

For this round of interviews, respondents were selected based on their role and belonging within the organization. In order to capture different aspects, the authors deemed it necessary to interview members of the developer, the constructor and the different support units. Furthermore, the interviewees for this round of interviews were selected from different hierarchical levels in the organization.

In order to create the best environment for the interviewees to express their opinions, all data from the interviews are presented as anonymous, apart from each respondent's title. All respondents were assured of this at the beginning of each interview. This would hopefully minimize any bias concerning a respondent's willingness to disclose information that could reflect individuals, or the organization, in a negative view. Furthermore, the importance of including names of the respondents was considered to be minimal with regards to the purpose of this paper.

In addition to the interviews, the company's internal documents in regards to risk management were reviewed. The reason for this was to create a better picture of the

intended risk management process, but also to be able to compare interview answers with internal guidelines. Although this paper will not disclose references to internal documents, the data acquired from such sources form large parts of the empirics.

### 3.6 Interviews

In total, 21 interviews were conducted with different employees of the subject company. The respondents operate in different roles and parts of the organization. The first round of interviews (interview A to F) was intended as a pre-study, with the purpose of exploring the subject of interest as well as establishing a direction for the rest of the study.

The second round of interviews (interview G to U) was focused on the four steps of the risk management model; risk identification, risk assessment, risk mitigation and risk monitoring & lessons learned. The interview guides for both rounds of interviews can be found in Appendix I and Appendix II, respectively.

The list below provides brief information regarding each interviewee's role and belonging within the organization.

#### List of Interviewees

<b>Respondent</b>	<b>Role</b>	<b>Belonging</b>
A	Business Developer	Developer
B	Project Developer	Developer
C	Project Developer	Developer
D	Project Developer	Developer
E	Project Manager	After-Market
F	Head of After-Market	After-Market
G	Project Engineer	Constructor
H	Project Manager	Constructor
I	Systems Developer	Support Unit
J	District Manager	Constructor
K	Project Manager	Constructor
L	District Head of Project Development	Developer
M	District Head of Business Development	Developer
N	Region Head of Residential Development	Developer
O	Business Controller	Developer
P	Peer-Review	Support Unit
Q	Workplace Manager	Developer
R	Project Manager	Constructor
S	Business Controller	Developer
T	Region Head of Residential Development	Developer
U	Business Council	Support Unit

*Table 1 List of Interviewees*

### **3.7 Reliability and Validity**

In order to evaluate the credibility of the study, reliability and validity must be taken into consideration. Reliability refers to how well findings and analysis can be consistently achieved if the study was to be repeated. Validity refers to how well findings actually reflect what the research is intended to capture. (Saunders, et al., 2009)

Threats to reliability could be based on either the participant or the observer. This can further be expanded to error or bias; for example, observer bias or participant error. (Saunders, et al., 2009) The authors of this study have taken measures to ensure that such threats to reliability are minimized. For example, participant bias will hopefully be avoided to some extent by assuring the respondents that their input will be anonymous to others than the authors. However, the nature of a qualitative study infers that findings will not be possible to duplicate to the full extent if the study was to be repeated.

One obvious threat to validity in this study is generalizability; since the study is limited to a certain company and market, findings might not be applicable to other organizations or other markets. Due to this, the authors of this paper will be transparent about the context of findings. By conducting further studies in the subject, one would be able to better test the robustness of the results.

It is worth noting that the market conditions during this study are favorable for residential development; demand is high and new development cannot provide enough residential properties to meet demands, especially in the city regions of Sweden. This could, to some extent, have an effect on how developers regard risk, since they know that selling units will not be a major issue. However, the price of land and supplies has gone up, which might counteract an optimistic mindset of developers.

# 4. Theory

*Risk management can be interpreted and applied in many different ways. This chapter will present academic literature in the subject in order to form a foundation for the study, as well as provide theory that can be utilized in analyzing the findings of this research.*

## 4.1 The Concept of Risk

Winch (2010) defines risk as an absence of information when a decision needs to be made at any time throughout a process. The correlation between risk and time is of great importance since risks can both occur at an instant, as a surprise, or can be identified in advance. The framework of time generates a basic understanding of how risk management can be applied. Regardless if a risk occurs instantly or it is identified in advance the risk stems from a source. The risks trigger an event that has a negative impact on the project itself. Lastly this event mandates a response. The response can be to the source; if the risk is identified in advance, or to the event; if the risk is not identified in advance.

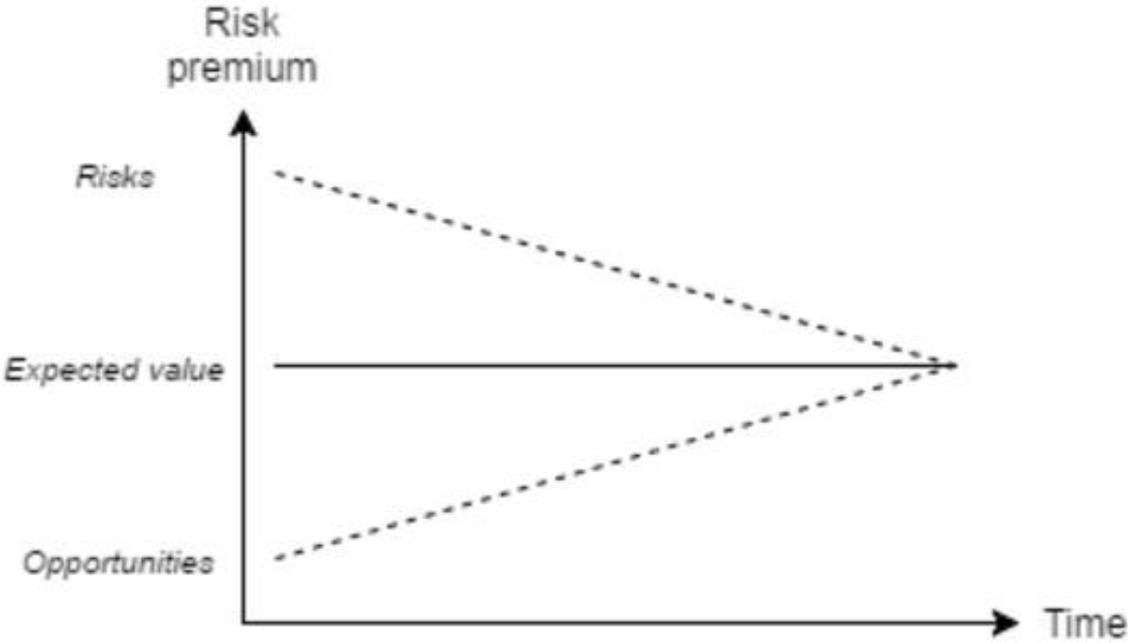


Figure 4 Risk premium over time. Adapted from Winch (2010)

Risk shows the absence of information, meaning that there is an uncertainty about what event a risk source will trigger. Therefore, a probability of occurrence can be assigned to risk in order to determine what impact the risk is likely to have on the project. Winch (2010) introduces four different schools on the relationship between risk and probability:

- The objectivist school: This school uses a statistical approach where it tries to predict future events based on data collected from previous sources.
- The logical school: Within this school the aim is also to predict the probability of an event. However, the decision made is not solely reliant on data; instead the experience and knowledge of the event is the key to identifying and assessing a risk.
- The subjectivist school: Where the two previous schools determine the probability based on statistical data and experience, this school aims to provide the user with explicit tools and techniques to solve the issue at hand.
- The behavioral school: In contrast to previous schools, this focuses on the behavioral aspects of decision making when faced with a potential problem.

## 4.2 Risk in Construction Projects

Within the academic literature, the risk management process in the construction industry approaches the different schools to different extent. A literary review conducted by Taroun (2014) shows that a technique called Probability-Impact is the most common one. Out of the four schools, the logical approach lies closest to this technique since it uses previous experience and data to estimate a probability of the identified event to create an estimate of impact. Often, the problem within the different schools is that there is insufficient data concerning a given uncertainty (Chapman & Ward, 2015). The reason given is often that the industry is becoming more complex and dynamic (Carr & Tah, 2001). As the project group grows throughout the process, the behavioral school becomes prevailing.

Within a project there are many participants that represent different entities such as consultants, subcontractors or architects. A principal-agent problem occurs when these representatives are the ones managing risks. Within the construction industry, the agent is considered risk neutral while the principal is risk adverse (Winch, 2010). Therefore, all represented companies in a construction project want to minimize their own risk. By using mitigation tools, risk adverse companies will try transfer the risk to avoid allocating the risk on their own. A common problem is that the one forced to allocate a risk is often the one least suited to do so. (Ward, et al., 1991)

In an environment where all parties are risk averse and wants to mitigate their own risk, it is hard for parties to collaborate. For a project to be successful, the party most suited to

allocate a risk needs to be the one doing it (Ward, et al., 1991). Osipova & Eriksson (2013) introduces the concept of joint risk management. Within such a process, all parties operate as one and take a holistic view on the project rather than focusing on their own parts of the project. When practicing joint risk management, all expertise is used and all risks are gathered for the entire project. Thereafter, all risks are identified, assessed and managed by all involved parties. Rather than individual project members needing to allocate risks they might not be suitable to manage. For it to succeed, the organization needs to be both flexible and controllable at the same time. (Osipova & Eriksson, 2013). Research shows that joint risk management introduces a more flexible environment into the project team and allows them operate more freely.

One solution to a more successful risk management is collaboration, since all members of a project group can share knowledge and experiences. It could be argued that this process would be easier if the project group was smaller. A design-build contract allows the contractor to have more control over the design process since they are the entity responsible for the technical solution. This allows the contractor to have the schedule overlap and shorten the process leading to reduced costs and schedule. (Brown, 2009).

By using Early Contractor Involvement there is a possibility to increase the collaboration within the project group and therefore minimize potential risks and maximize opportunities. This means that a contractor is procured in the earliest stages of the project and has the contractor assist the developer or owner. Since not all risks are identifiable in the early stages (by the design team) the contractor can recognize potential construction risks since their core business, and core competence, is production. This ensures that the entire preconstruction process operates more smoothly and this also increases collaboration within the project group. (Mosey, 2009) The key term is core competence. When one is an expert at a certain field it is inevitable that they also generate extensive knowledge about their field.

The actual practice of risk management in construction projects have been examined in the literature. Several questionnaire surveys have been conducted with a purpose to explore subject of risk management (Taroun, 2014). The results from such a study, performed in the UK, indicated that contractors and project management professionals rely mainly on intuition and personal experience when managing risks (Edwards & Bowen, 1998). Similarly, a study on project risk management in Hong Kong indicated that experience and personal judgement was considered the most effective approach to managing risks in the construction industry (Shen, 1997).

Both studies find that the reason for not using more formalized risk analysis techniques is, partly, due to a lack of understanding and experience in such methods. Akintoye and MacLeod (1997) also identifies time constrains as a reason for not using formalized risk analysis. Akintoye points out that time constrains is an inherent problem of construction projects due to the fact that most construction projects are engaged first upon the client's

request. Another aspect identified by Shen (1997) is that quantitative analytical techniques might not be regarded as suitable in construction projects.

In somewhat of a contrast to the above, a qualitative study on risk management conducted by Wood and Ellis (2003) indicate that lack of knowledge or understanding is not a main reason for not using complex quantitative techniques in the construction industry. Rather, it seems to be because of practitioner's skepticism towards the usefulness of such techniques.

When conducting risk management, an underlying problem is the bias that could occur when risks are assessed, an approach that is to be described as heuristic. Winch (2010) introduces three systematic biases regarding risk assessment:

- When assessing risks there is a small sample size. Winch illustrates this with an example that a project will be faced with budget overruns and schedule delays as both a construction budget and schedule are simply the mean of all available estimates. The lack of *repetitiveness* means that no assessments can be fully viable.
- The lack of comparable information creates a bias referred to as *availability*. Where decisions are based on the last available information or solution from a complex problem. The problem lays in that there is no evidence that the solution or information is relevant to the current problem.
- The last bias introduced is *anchoring*. That is when the initial assessment or solution overshadows any solution once new information emerges.

The different forms of bias are hard to overcome and there is no definite solution to the problem. Different methods and techniques, such as training, can help minimize bias but there are no certainties. (Winch, 2010)

Despite the vast research available regarding risk management in construction there are discrepancies regarding to which extent the different tools and techniques are used in reality. The authors (Raz, et al., 2002) performed a study based on data collected from over 100 different construction projects. Their result shows that even though there are great amounts of tools and techniques available they are not widely used. The reason described is that it is still not an integrated part of project management and that there is a lack of awareness of the tools and an over-optimism: meaning that project managers need to realize that projects suffer unexpected outcomes and that they need to be aware of these uncertainties.

A result of their study also shows that there are times when risk management techniques and tools are adequately used. That is when project managers are faced with a delicate or particularly advanced project, where the risks are expected to be greater. Even if this is viewed as something good the authors states that this is somewhat alarming. As this indicates that "safe" projects fail to use the proper tools and techniques and therefore they

fail with mitigating risks. However, the authors bring out an interesting point; when faced with a difficult project the project members tend to give such project more attention, care and use more risk management tools to mitigate risks. This leads to the conclusion that there is no certainty if it is the tools themselves or the increased attention (related to project difficulty) that decide if the risk management process is successful.

A different problem regarding risk management in construction projects is that there is a large emphasis on the tacit knowledge. Traditionally, risk management is based on previous experiences and therefore the decision making process regarding all risks becomes of a subjective nature. Therefore, the industry needs to address new and innovative approaches to risk management. (Baloi & Price, 2003)

### 4.3 Risk Management Model

The process of risk management could be seen as a single part in the overall process of project management. However, in order to better analyze risk management it is possible to delineate the process into several steps. This has been done by several researchers previously, in a variety of different ways. Common traits in many previous articles on the subject identify the following four steps (Banaitiene and Banaitis, 2012):

- Risk Identification
- Risk Assessment
- Risk Mitigation
- Risk Monitoring

Together, these steps reflect the key aspects of risk management. Most, if not all, activities that relate to risk management in projects can be tied to these categories.

The model below shows the different steps within the risk management process.

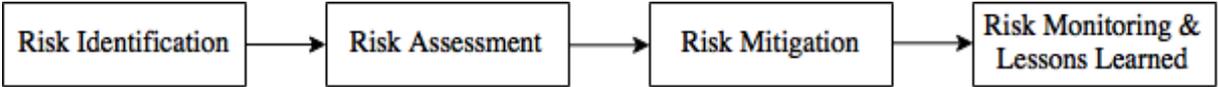


Figure 5 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

In the following section, each of these steps will be explained in order to provide a better understanding of the model.

### 4.3.1 Risk Identification

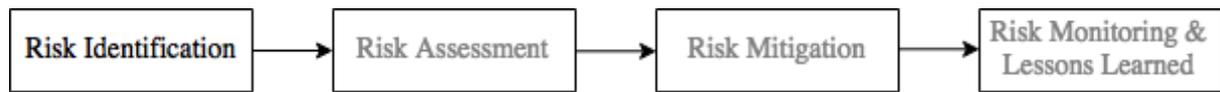


Figure 6 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

Risk identification, as the name implies, is the process of identifying potential risks and its sources during the project timeframe (Ahmed et al., 2007). This step in risk management is perhaps the most vital one, as it lays the foundation for further risk management in the project (Banaitiene and Banaitis, 2012). Failure to identify risks may later on lead to delays and budget overruns (Raz et al., 2002). The importance of identifying risks is further stressed as not only allowing for better risk assessment: but also for allowing the different project members to be aware of identified risks in order to find the proper mitigation strategies for them (Ward, et al., 1991).

Goh, et al., (2013) establishes that even though there is no given risk management technique that is applicable to all scenarios, the most common ways of identifying risk are defined by the authors Lyons & Skitmore (2004) as either brainstorming, case-based approaches and checklists.

A different approach to identifying risks is presented by (Hanna, et al., 2013). The authors describe the risk identification process as two-folded. The initial step is conducted by a single entity and is referred to as risk alignment; a process where the project risks are identified and assessed based on how it will affect the entity itself. Often, these risks are identified based on the experience generated within the company and its personell. The second step is when two or more entities unite to perform risk identification. The purpose of this process is to ensure that all risks are identified, and more importantly allocated, by the proper entity.

A similar approach in the collaborate nature is joint risk management. It is described as a powerful tool to identify and allocate risks. By including multiple project members with different experiences (e.g. contractors, developers, consultants), the project group can ensure that there is sufficient knowledge and competence within the project group to identify risks. Furthermore, it is important that there are collaborative elements included in the contractual relation between the parties. Meaning that there is an incentive to ensure the best possible mitigation strategy for a risk, rather than transferring the risk and getting stuck in financial negotiations. (Osipova, 2015)

### 4.3.2 Risk Assessment

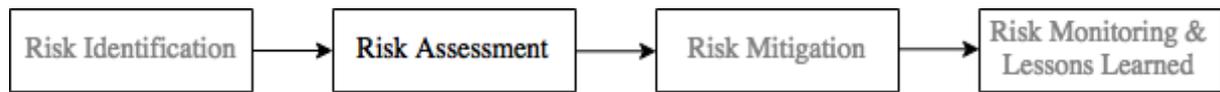


Figure 7 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

When successfully having identified risks, these should be assessed and analyzed in order to determine whether or not further actions need to be taken (Ahmed et al., 2007). Risk assessment may also include the process of measuring risk, in order to make it quantifiable and comparable.

Parallel to the changed perception of risk management and its importance to project management, different methods have been developed in order to assess risks. These methods have ranged from using probabilistic tools and Monte-Carlo Simulation to Fuzzy Sets Theory. However, the most prevailing method in recent literature is modelling risk as a multiplication of probability and impact, namely the Probability-Impact risk model (Taroun, 2014).

Although it is recognized that the Probability-Impact model is most frequent in recent literature it has received critique. Chapman and Ward (2000) argue that the Probability-Impact model may seem to be a quick method for determining risk within a project, but that it is too much of a simplification to be of any real use.

Moreover, several researchers have suggested alterations to the Probability-Impact model. Predominantly, these suggestions include a third dimension to be included in the model, other than probability and impact. For instance, Han et al. (2008) suggested that “risk significance” should be included in order to represent the intuition and personal experience of the professional that identifies a specific risk. Jannadi and Almishari (2003), on the other hand, had suggested that “exposure” should be added to the model in order to reflect how frequently a hazard occurs. Yet another alteration is suggested by Cervone (2006) who includes “discrimination” in the model. Cervone uses “discrimination” to provide a perspective on the risk to the overall framework of the project, instead of considering each risk as an independent variable.

When risks are assessed, the risks are often quantified by giving them a monetary value which is described in academic literature as a risk premium. The risk premium depends on a variety of sources. The reason for this is that different entities value risk depending on their attitude towards a certain risk (being risk averse or not), how experienced the entity is at mitigating a given risk, and the estimated impact, among others. (Akintoye & MacLeod, 1996)

### 4.3.3 Risk Mitigation

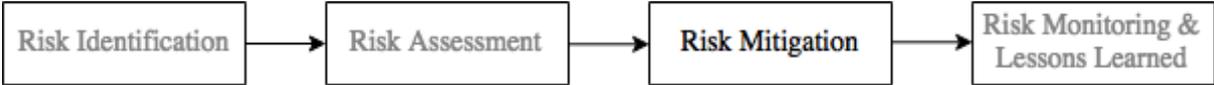


Figure 8 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

The action of mitigating risks is often the weakest part in the entire process. It requires all involved parties to fully understand their responsibilities and capabilities in the matter. (Banaitiene & Banaitis, 2012)

Risk mitigation can be seen as either qualitative or quantitative. The qualitative mitigation strategies can be when risks are discussed via brainstorming, where project member's individual knowledge and experiences are used to form the strategy. Another example is predetermined checklists, based on lessons learned and best practice. The quantitative approach uses data to determine probability and impact using, for example, Monte Carlo simulations and other data-driven methods. (Banaitiene & Banaitis, 2012)

Apart from the aforementioned qualitative and quantitative approaches, strategic decisions can be made to mitigate risks. The more common ones are: risk avoidance, risk acceptance or risk transfer. (Banaitiene & Banaitis, 2012)

The problem with strategic decisions to mitigate risks arises when risks are not mitigated by the party most suitable to manage the risk. If risk avoidance is used as a strategic option, then problems may arise if the party most suitable to carry a risk tries to avoid it, which in turn can halt the project from moving forward. Similarly, risk acceptance works if the risk is allocated by the party most suitable to manage the risk itself. If the risk is accepted by the "wrong" party, it can create implications. It is important to note that parties should be aware of all risks related to a project to ensure that the party absorbing the risk is able to mitigate it properly. (Akintoye & MacLeod, 1996)

### 4.3.4 Risk Monitoring



Figure 9 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

As a final step in the model, risk monitoring includes activities such as observing the outcome of risk mitigating strategies and evaluating their effectiveness. If the taken countermeasures are deemed to be inefficient, other strategies need to be adopted (Carr & Tah, 2000).

Even though risk monitoring is the last step in the model, it does not indicate an end of the risk management cycle. The model depicts an iterative process that could be repeated several times over the course of a project (Tah and Carr, 2000).

The monitoring process (which is presented as both monitoring and lessons learned by the authors) can be regarded as a continuous process. In other words, the project team is to both monitor and review risks through all previous steps of the risk management process (Ahmed, et al., 2007).

Risk monitoring is essential for project members to ensure that the predetermined mitigation strategy works, in case the identified risk is actualized. If the risk is actualized, the project members need to evaluate the risk once again and assess the outcome. Regardless if it is actualized or not, monitoring risk allows the project team to remove it once deemed viable. (Tah & Carr, 2000)

#### **4.4 Knowledge Management Related to Risk**

Knowledge management is closely related to the risk management process. Because of the iterative nature of this model, it is essential that knowledge about risks and remedial strategies is not lost; thus, organizations will less frequently make the same mistakes more than once. Furthermore, having knowledge about risks, and countermeasures, should not solely stay within that specific project. Rather, it would be favorable to share that knowledge with the rest of the organization.

Given the inferior data collected about risks in construction industry makes it hard to analyze the risk management process using only a probability-impact model or other statistical models. Instead, the industry uses a qualitative approach by combining the subjectivist school with the logical school. By using gained qualitative data, i.e. knowledge, and reusing successful tools of risk management, an organization can try to gather experiences and learn from previous projects. (Banaitiene & Banaitis, 2012). However, this can prove hard since the industry suffers from a modus operandi behavior which results in a lack of consistency; in turn, this can create problems generating knowledge. (Rezgui, et al., 2010). Therefore, knowledge is important when discussing risk management.

Knowledge can be generated by any effect or any event. Regardless of effect or event, knowledge can ascend in any format. Knowledge can roughly be divided in to two different categories:

- *Explicit knowledge* is any knowledge acquired through external sources and can be understood and stored without any difficulty. It could be from reading an instruction or looking at a drawing.
- *Tacit knowledge* is the knowledge generated from experience and reflection which can be hard to codify and hard to transfer. However, it could be transferred from a

mentor explaining how a situation works but it is a longer process than explaining explicit knowledge.

The construction industry is known for consisting mostly of tacit knowledge and this poses a significant challenge for the industry. Khuzaimah & Hassan (2012) further describes tacit knowledge as: “[...] unstructured and hidden knowledge which is acquired over a period of time through experience, reflection and intuition”. Therein lies the problem of having a well-functioning risk management process. To uncover tacit knowledge from individuals, an organization needs to transfer the individual knowledge to the rest of the organization. There are different opinions arguing if this is possible or not. Khuzaimah & Hassan (2012) states that there are claims that tacit knowledge is inaccessible and therefore impossible to transfer. However Nonaka, Toyama & Konno (2000) explains knowledge transfer using the SECI-model. According to the model tacit knowledge can be transferred to an organization using two different techniques. The first one is called socialization, where knowledge is shared by interacting with one another. Within the construction industry this is conducted through mentorship and teambuilding activities where experienced individuals train inexperienced ones. The second is externalization, where individuals with vast tacit knowledge transfer the knowledge by, for example, writing guidelines or creating work processes.

In the aforementioned literature it is introduced that knowledge is related to risk management and especially how knowledge is utilized within an organization. In extension, concepts from organizational learning are applicable to risk management as well. Especially two concepts are introduced in organizational literature; exploration and exploitation. Where exploration is the concept used when an organization strives to create new knowledge through inventions or new findings. While exploitation is when an organization creates knowledge through refining previously used solutions (March, 1991). The balance between the two concepts are described as organizational ambidexterity (Eriksson, 2013). It is argued that many organizations focus too much on exploitation since the benefits and positive results occur directly when refining an already established project process, whereas positive results from exploration occurs in the future. The downside described by March (1991) is that when an organization focuses on exploitation they will only gain short-term success but fail in gaining long-term success. Furthermore Eriksson (2013) discusses that the construction industry (working in a project based format) needs to utilize what is referred to as contextual ambidexterity since it is deemed as “... a viable solution for subsystems with scarce resources.” (Eriksson, 2013, p.337. This helps the organization to create systems where the project members can find an adequate balance between exploration and exploitation. Rather than other forms of ambidexterity that are more applicable to large-, and hierarchical- organization.

Push-learning and pull-learning are two concepts related to how an individual are willing to learn and accept knowledge. The two concepts distinguish the difference between how

individuals have a willingness to learn. Within push-learning the individual is unable to acknowledge what they need to learn in order to solve a problem. Within an organization where push-learning is prevailing, consultants are often hired to solve potential problems since the organization itself is unable to do so. The opposite is pull-learning, where individuals are able to utilize their own skills and alter them to solve a given problem. Therefore, the members of an organization can learn how to solve a problem themselves rather than learning or being trained by an external individual. Push-learning is viewed as the prevailing learning method within the construction industry. This is deemed as one of the sources to production related problems that can be identified within construction projects. (Santos & Powell, 2001)

#### **4.5 Relationship Management Related to Risk**

Winch (2010) argues that the basic problem related to supply chain management is the lack of proper information within the earlier stages of a project. During a construction project life cycle, there are many uncertainties as the projects often are unique, and the possibility of repetitiveness is slim. Therefore, involved suppliers are forced to form decisions based on incomplete information which increases the risks within the project. The uncertainties within the project are larger during the earlier stages of the life cycle. During the project development stage the concept is formed. At that point, there are no finalized drawings and insufficient details regarding the project.

The relationship between the different entities involved in a construction project is described by Winch (2010) as either horizontal or vertical:

- Vertical governance is also defined as the project chain; that is the relationship between the owner and the first tier supplier. Within the residential development market, the relation can be between the developer and its procured contractor.
- Horizontal governance is also defined as the supply chain; the relationship between the first tier supplier and second tier supplier. For the residential development market, it can be explained as the relationship between the procured contractor and its subcontractor.

The difference between the aforementioned styles of governance is dependent on the contractual relationship between the involved parties. Winch describes the concept of integration where, in a project based format, the responsibility is transferred to a single entity. The outcome is that the horizontal entities (supply chain) are integrated to the vertical entities (project chain).

A different problem Winch (2010) describes when managing the supply chain, is shirking. Shirking is a result of the asymmetric information between the employer and the employee.

Only the employed entity truly knows how affective they can operate. Therefore, the owner or first-tier supplier can never know if the entity hired is maximizing its effort. Thus, the owner or first-tier suppliers are exposed to unnecessary costs and risks.

The result of the asymmetric information within a project in response to uncertainties creates for different relationships and management techniques. The purpose of most techniques is to increase the collaborative element within the project. The contractual form between the involved parties stipulates the responsibilities. A design-build contract allows for less horizontal governance since this integrates more entities within the project chain. On the contrary, a design-bid-build contract calls for more horizontal governance as this increase the supply chain.

Winch (2010) further develops the different approaches on how to manage, depending on product and the repetitiveness in the relationship: spot-market sub-contractors, consortium, quasi-firm and joint-venture. Apart from these, introduced by Winch, there are different types of relationships that have surfaced within the academic literature. The aforementioned Early Contractor Involvement is one that is related to the design-build format; where the contractor is involved in the earliest stages of a project to submit their competence and knowledge (Mosey, 2009).

A similar approach to Early Contractor Involvement is Partnering. Partnering is a concept where two or more entities engage in a long-term relationship with the purpose of using each other's competence and maximizing the outcome of each participating entities' resources. The relationship is to lock beyond a single project and instead collaborate in an array of upcoming projects. Partnering is described in an article by Bygballe, Jarhe & Swärd (2010) as: "*The most significant development to date as a means of improving project performance*". However, the authors acknowledge that the concept of Partnering have not had a substantial impact. It is explained that the focus is not on involving all parts of a construction project, apart from the owner and contractor. Furthermore, the article explains that, in order to succeed with partnering, the involved entities need to prioritize decisions on whom they are to partner with, examine how the different relationships affect each other, and include informal aspects within the Partnering process.

The relational history is deemed as a crucial element when deciding to use Partnering. Often, Partnering is not chosen as a predetermined procurement method by an owner. Instead, it is a result of a previous relationship or knowledge of a certain counterpart. A case study performed by (Crespin-Mazet, et al., 2015) shows that, when deciding to use Partnering in a project, the decision is based on that previous knowledge. If a relationship is already established, then the entities are inclined towards Partnering since routines and solutions are already implemented. The study also shows that the relationship towards other actors within the field have a large impact when deciding on whom to partner with.

## 5. Empirics

*This chapter will present different tools used for managing risks, as well as presenting the overall process of risk management process within the company. This is then followed by a presentation of the interview results, structured according to the risk management model presented in chapter 4.3.*

### 5.1 Tools for Risk Management

*Unless explicitly stated, the empirics found in this sub-chapter are based on text-analysis of internal documents and guidelines.*

During the course of the study, different tools for managing risks have been identified in regards to risk management. In this section, they will be presented in more detail to enable further discussion of how tools are interconnected with the risk management process.

#### 5.1.1 Estimation Tool

Both the developer and the constructor within the company use an internal computer program to compile costs and revenue for each project. This program will henceforth be referred to as the estimation tool. The estimation tool covers several different aspects of the project, risk being one of them.

Internal guidelines regarding the estimation tool refer to the use of brainstorming, checklists and interviews as feasible ways of identifying risks in a project. After having identified risks, these can be listed and structured in the estimation tool. Furthermore, the guidelines suggest that each risk is assigned to a person responsible for that risk. This should be someone with adequate competence and authority to take decisions regarding that specific risk.

Following the identification of risks, the estimation tool provides several means of analyzing individual risks and their joint effect on project outcomes. This includes the use of the Probability-Impact method and Monte Carlo simulations. Depending on the type of risk, analysis can either be done using a monetary or non-monetary method. In the estimation tool, the Probability-Impact method is used for analyzing risks in a non-monetary manner. Respectively, Monte Carlo simulations or calculations of expected value can be used for analyzing risks in a monetary manner. According to the guidelines, the non-monetary method in the estimation tool mainly applies to risks regarding health, environment or goodwill.

Based on the analysis, a decision should be taken as to how different risks should be treated. The estimation tool provides users with the ability to log different measures in regards to specific risks. Consequently, users can keep track of what risks are taken care of and what

risks remain. This should ensure that available resources are focused on the most considerable risks.

### **5.1.2 Project Book**

Similar to the estimation tool, the project book is used to compile cost and revenue for each project. In form, the project book is structured as a set of spreadsheets. The project book is used to simulate different budgets for a project and also the tool used for the developer before each forecasting period. However, presenting the project budget with the use of the estimation tool is required to pass certain tollgates.

Even though the project book is preferred when simulating project outcomes, it provides fewer possibilities to simulate different risk outcomes. In the project book, risks can be logged in a list with a short description and an expected value.

### **5.1.3 Standardized Building Solutions, Guides and Manuals**

Via the company's intranet, one can access a database containing numerous building solutions, guides and manuals. These are created from lessons learned and best-practice; providing developers with standardized solutions that have been used previously with good results.

This can be considered a risk management tool in the sense that it promotes the use of low-risk products and production methods. The database is kept up-to-date by support units, depending on the type of information. Although this database is constantly available, it is not mandatory in all aspects. Thus, it is up to the developer to choose if any of the standardized solutions should be used within a specific project.

### **5.1.4 Peer-Review**

As a way of minimizing recurring risk sources in projects, a peer-review function has been initiated by the company. The peer-review group consists of several individuals with a lot of experience within the field of construction and development (Respondent P).

The peer-review group is responsible for reading up on every project, thereafter reviewing risk sources together with project members by following a pre-determined checklist. The peer-review group continuously updates this checklist with reoccurring or critical risk sources (Respondent P).

### **5.1.5 Risk inventory**

The risk inventory is an internal document that both the developer and contractor have to provide in order for a project to be allowed to proceed through the tollgates. The risk inventory consists of a checklist based on lessons learned and best practice. The different parts of the checklist correspond to previously identified risks and each risk is given a possible outcome and a probability.

The checklist is a probability-impact model; if the multiplied value of the two factors reaches a critical limit, the project members need to create a workset or contingency plan for the specific risk.

## **5.2 The Risk Management Process in the Subject Company**

*Empirics in this sub-chapter is based on text analysis of internal documents regarding the company's management system.*

The risk management process is an integral part of the work process. This is where risks are both identified and managed. The process goal is to minimize “loss-projects”, increase the predictability within the projects, while also managing all crucial aspects involved when conducting construction projects.

On a group level, the company adheres to what is referred to as a Heat Map. Each business unit adheres to this process and all units have their own regional Heat Map. The map is used to identify crucial risks that could occur within a project and are linked to four core attributes: competence, geography, contract form, and contract size. Each project is evaluated according to these attributes and each attribute are given a value. This is done to identify potential risky projects and stipulate the best response. The value provided in the Heat Map also stipulates how the project group needs to respond, and to whom in the internal work process. Besides the core attributes related to a project, there are ten different risks specified that are identified as crucial risks. The crucial risks are also used to guide to project through the internal decision process. The purpose of the Heat Map is to provide the organization with not only information on risks, but also guide the organization through the decision making process and which instance have decision making rights.

On a group level, there is a governing board consisting of the executive team from the different business units, referred to as the executive board. The executive board is the governing body deciding on all projects that are identified as crucial (via the Heat Map), or projects that exceed a certain revenue. There is a preparatory board called risk team. They have the initial meetings with the project organization and summarize the different projects before they are being presented to the executive board.

On a country level, the organization has a project council consisting of the country CEO, chief counsel, risk manager and members from the country's executive team. The council has the right of decision to a certain degree, decided by the Heat Map. The project council manages all aspects related to the construction side of a project.

In comparison, there is a business council consisting of country VP and CFO, among others, that operates as the project council, but instead focusing on all aspects related to the development side of a project.

All residential projects are initially managed by the business council. However, if the project exceeds certain revenue, the project needs to be approved by the governing body through the aforementioned processes according to the Heat Map. The decision making process differs within the organization depending on both the Heat Map and the project; e.g. commercial or infrastructure.

The risk management process for residential development consist of two separate parts where the developer adheres to a given work process and the contractor adheres to another. However, the contractors risk management process is integrated with the developer's in several of the stages through the construction life cycle.

The company works with a tollgate system. Before a project can continue past a tollgate, a Request for Investment (RFI) is sent to a governing body. To which instance depends on which tollgate it is and the total project revenue. The RFI covers key figures, project description, intended target market, revenue calculation and potential risks and opportunities. The purpose of the tollgate system is to guide the organization while securing the quality of both the product and the process. Within the RFI documents sent to the governing body, the most important risks and opportunities are presented. These are subsequently assessed by the governing body.

On a country level, the construction company works with several different tools and techniques to minimize risks and maximize opportunities. These tools and techniques are not related to specific projects and are a result of generated knowledge from previous projects.

Apart from the RFI process, the company uses an analytical tool that creates a baseline for production costs as well as developments costs. The tool collects data from previously conducted projects to supply the organization with key figures on reference projects. The tool is used to compare the risk assessment between projects.

The company operates with predetermined building parts in order to minimize risks. There is a support unit that gathers previous experiences from residential production and evaluates them using best practice. The building parts at hand are parts that are repeated in other residential projects (staircase, elevators etc.) The purpose of using predetermined building parts is to reduce the risk by helping the project organization not to reinvent

solutions. The predetermined building parts are to be used in all available situations. Apart from predetermined building parts, the unit also supplies guides and manuals on more complex parts of the construction process. The company uses a checklist to ensure that each residential project use the correct building parts and motivate any discrepancies.

Another tool used to minimize risk, is “lessons learned”. The after-market unit provides documentation on warranty issues related to the product, where the project organization can ensure that previous errors are not repeated.

### **5.3 Risk Management Process for Residential Development**

*Similarly to the previous sub-chapter, the following empirics are based on text analysis of internal documents regarding the company’s guidelines and management system.*

When a project has been identified, it is initiated by the business developer. Each region operates in the most suitable way for their local market. For each new project, a project mission is stated; the business developer is to define the project and identify if any predetermined building parts can be used in the project. Before the project reaches the first tollgate, the business developer establishes a project book where the initial risks are documented. The risks are also documented in the estimation tool that is used by both the developer and contractor. Identified risks are assessed as a flat rate based on previous projects and previous experiences, and the analytical tools helps with providing the flat rates. The regional manager for both the developer and contractor need to approve the project mission to ensure that the project is viable for both entities and the contractor provides a tender. For the initial tollgate, no separate risk inventory document need to be produced.

Once the initial RFI is approved, the project moves to the second tollgate. The process starts with a meeting between the developer and contractor, to ensure that both parties are updated on the project. In the preparatory work, different investigations are conducted to identify potential risks. Apart from identifying and assessing risks in the project book, a risk inventory document is prepared. The risk inventory is a document that gathers potential risks that have previously been encountered in residential projects. Within the document, identified risks are given a probability and consequence. The combined value stipulates how the project group needs to respond. If the value exceeds a given number, the project group needs to provide a workset. The risks reported in the project book are updated at the end of the tollgate.

The next gate starts with a handover meeting where the business developer informs the rest of the expanding project group (both developer and contractor) about the previously identified risks and an action plan is implemented on how to mitigate the risks. The group also discuss if any new risks have been identified. As the design process continues and the concept is further developed, the project is screened by a separate peer-review unit. The

peer-review unit consists of experienced individuals that does an in-depth review of the project. Based on their previous knowledge, they have formed a forum where all parts of the project (drawings, schedule, financial, production etc.) are discussed. The peer-review team uses lessons learned and best practice to ensure that all parts are successfully reviewed. The peer-review is conducted on two different occasions during the project life-cycle to ensure that all aspects are examined and nothing is left unnoticed. The purpose is to secure a successful project.

The risk inventory conducted in the earlier stages is updated. As the design process continues, the project team is to, once again, ensure that the product is designed using the predetermined building parts. During this gate, the project team also identifies workplace-related risks related to the design phase using a checklist. This is done with the purpose of possibly altering the product to create a safe work environment. During the earlier stages of the project, before the concept is decided, risks are mitigated through altering the concept or product, in collaboration with the municipality; or by providing action plans such as extensive investigations. During this stage, the developer engages the contractor and provides them with the project scope.

Once the contractor receives the scope they initiate their tendering process. The district manager ensures that the scope provided is approved in accordance to the Heat Map, before the tendering process can be initiated. The Heat Map stipulates if the contractor needs to establish an Operational Risk Assessment (ORA). The ORA provides the scope, the tender and information about the client, as well as all the identified risks. The ORA process is similar to the previously mentioned RFI process that the developer adheres to. The ORA is analyzed and approved by the governing body before the tender can be submitted. The contractor also submits a risk inventory similar to the one that developer submits and risks are identified and assessed from the contractor's perspective. The risk inventory for the contractor works in the same fashion as the one for the developer. Each identified risk is given a probability and a consequence. Each identified risk is then given an action plan or workset and a project member responsible for the specific risk. All risks identified are also reported in the estimation tool. Furthermore, technical consultants and experts are asked to provide an independent risk inventory within their respective field. Throughout the tendering process, the risk inventory will be continuously updated as new risks are identified and previous risks are mitigated. If deemed necessary, a separate risk coordinator or risk group is designated to the project.

As the project enters the next two tollgates, the developer continues the design process and the building documents become more detailed and are later finalized. During the first of the two tollgates, the design-build contract is signed between the developer and the contractor. The project group now consists of both the developer and the contractor, and they collaborate on the risk management process. They both continuously revise and update their own risk inventory and provide their core competencies to help their

counterpart update theirs. They also update the checklist for work-related risks. The drawings are also revised to utilize the predetermined building parts to the maximum extent possible. The project group examines earlier projects and gathers any experiences from those projects and uses lessons learned to be more effective in the risk management process. Together they provide a project plan that, among other things, consists of the risk mitigation process where action plans for specific risks are prepared. Before the project can leave both of the aforementioned tollgates, the project needs to be approved by the governing body that evaluates both the developer’s and the contractor’s risks.

During the production stage, the risk inventory is once again updated and all project members have a shared responsibility to identify any additional risks that could actualize. Risks are updated by both the developer and contractor every forecasting period. The contractor also updates their ORA.

Once production is completed, the project is closed and the after-market units from both the developer and contractor are involved during the time of warranty. This is the final tollgate and it starts with a project evaluation where the entire project is evaluated. One large part of the evaluation is the risk management process. The project team reports the knowledge generated from the project to the rest of the organization to share the knowledge. The company’s risk management process described in the management system is illustrated below.

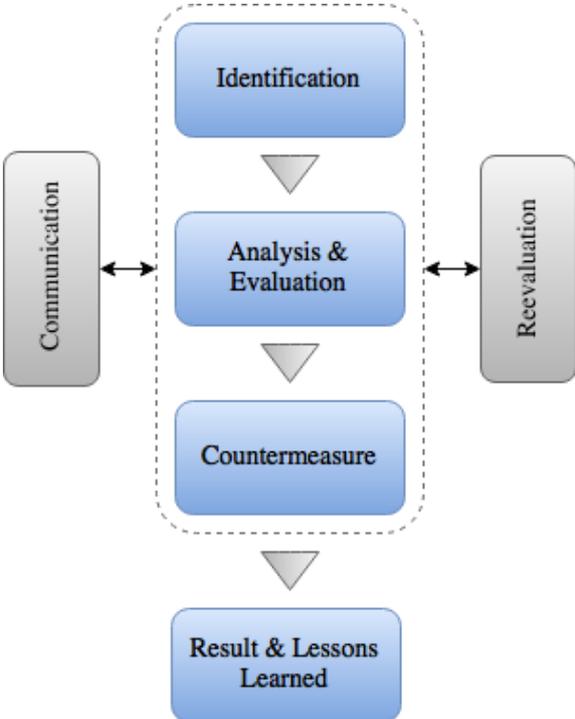


Figure 10 Intended risk management process (Author's own adaptation of internal documents)

To summarize, the company intends to work according to the following process: identification, analysis and evaluation, countermeasures, and outcome & lessons learned. During the first three steps, the process is linked to two outside sources: communication and follow-up/reevaluation. This model somewhat resembles the risk management model presented in chapter 4.3.

## 5.4 Interview Results

The following chapter presents the interview results, structured according to the different steps of the theoretical risk management model.

### 5.4.1 Risk Identification

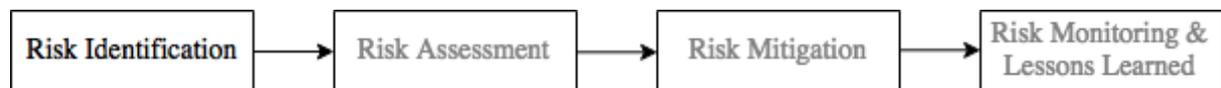


Figure 11 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

While the types of risks clearly differ depending on the different stages of a construction project, and the different roles of project members, there seems to be consensus regarding that identification of risks is mainly based on personal knowledge and experience. As stated by one respondent; *“After being part of a number of projects, you know what could happen”* (Respondent H). This view is shared by both members of the constructor and the developer.

Furthermore, the knowledge and experience gained from previous projects is often utilized in combination with standardized checklists. One respondent states that risks are identified by the constructor using *“both a basis of experience as well as checklists that can, and should, be referred to”* (Respondent J). The same goes for the developer; one respondent mentions that *“A risk inventory should be reviewed early on. However, it will not be sufficient. By brainstorming, more risks can be identified and added to the list”* (Respondent L). The importance of not solely relying on pre-set checklists is strengthened by another respondent; *“Although, there is a template for how to identify risks, it would be foolish and lazy to rely on that alone”* (Respondent H).

In addition to the above, some respondents have indicated that the use of standardized checklists and manuals as an aid in risk management is most helpful for those that have not yet acquired enough experience. One respondent states that *“It is easier to lift up those that are the worst to a decent level, than to lift up the best to become even better. That is what we do with manuals and work processes; raising the overall level. In order to become even better requires experience”* (Respondent G). Similarly, another respondent thinks that *“A lot of new people think that they [manuals] are very good. Meanwhile, if you have been working for a long time, you think that you know*

*your job well enough and, maybe, don't even look in the guidelines to see whether you work as intended"* (Respondent O).

In regards to when risks are identified, the majority of the respondents state that it is in the process of establishing a risk inventory. Since the risk inventory is a prerequisite for passing certain tollgates, some of the respondents feel a lack of continuous work with risk identification throughout the project; *"It [the risk inventory] becomes a static document that is established but not managed properly. It should be 'alive' throughout the entire project"* says one respondent (Respondent H). Similarly, another respondent indicates that *"The risk inventory should be worked on continuously. However, that might not always be the case"* (Respondent S). One respondent also voiced an opinion in the matter; *"You often discover risks while working with something else. More so than when you actually sit down and try to brainstorm risks. Unfortunately, the latter method is prevailing, even though there is systems support to add risks continuously as they appear"* (Respondent I).

The reason as to why risk identification is not always being carried out continuously throughout a project is, according to some respondents, time and resource constraints. In the words of one respondent; *"Historically, it has either been because of being in a rush, or because of staff turnover which, in turn, means that things become forgotten"* (Respondent L).

Given the different nature of the developer and the constructor, and their respective tasks within a project, they focus on different types of risks within a project. From the interviews, it becomes apparent that the constructor considers product- and architectural related risks as the most critical ones in the primary stage. This is more or less based on the complexity of the product; whether or not the architect has had a big influence or if it is a standardized solution. This ties together with the people responsible for a certain project, as stated by one respondent; *"When you first hear of a job, you start identifying risks – who is running it? That's what I call a big risk. With the wrong people starting a project – you don't know if you even want to be involved"* (Respondent G). This is aligned with the opinion of another respondent; *"Who is the client? Who is active within the client firm? It's one thing to have a client that you know, but will they have their own staff operating the project or will it be a consultant?"* (Respondent J).

Later on, the constructor's focus shifts towards risks related to variations in production cost. Fewer changes can be imposed to the actual product so the risk identification is more a matter of estimating cost variations in production material or effects of delay in the supply chain (Respondent R).

The developer, on the other hand, is usually involved in the process at a much earlier stage. Then, the risk identification will vary depending on the circumstances; e.g. if there are uncertainties as to how the detailed plan will be changed by the municipality could impose considerable risk to a project. In other words, the modelling of the product and the timeframe for the project are great sources of risk at an early stage (Respondent A). Apart from that, sales and market is analyzed at an early stage to identify potential risks. Since the

product has, most likely, not been planned in detail at the earliest stages, risk identification cannot be too specific. As one respondent stated; *“It depends on the phase. In the first stages, it [risk identification] is very general; it would be if the project has any exceptional traits”* (Respondent K).

In several interviews, an emphasis is put on the importance of using the collective knowledge of the organization. Bringing in experts from different departments is generally vital to more accurate identification of risks of different nature. As stated by one respondent; *“We have different backgrounds which give a mix of people. That is also how we work with our support staff, which is important in the early stages. For example, Financial Services value financial risks [...]. Then there is Law, which we always use to ensure an adequate level of formality in agreements. They also estimate risk, and that’s what our support staff is there for”* (Respondent M).

### 5.4.2 Risk Assessment



Figure 12 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

Risk assessment is in many regards similar between the constructor and the developer. As have been mentioned previously, a risk inventory is established when entering a new project. In the risk inventory, risks are assessed and graded, by both probability of occurrence and impact on project outcome. Subsequently, the respective grades are multiplied in order to give an overall grade to every specific risk. When this overall grade passes a certain threshold, mitigating measures must be planned for. As was found in the interviews, this method of assessing risks is a prerequisite to pass certain tollgates of the project process (Respondent D).

However, in the continuous work with a project, risks are also assessed in the project book (Respondent B). The project book is a tool for budgeting, where revenue and cost is compiled to reflect the profitability of a project. In this context, risk has a negative impact on project profitability. On the other hand, if a risk is successfully eliminated or in other ways do not actualize, the amount set aside in contingency for that risk will count as profit. As one respondent put it; *“You set aside an amount for the worst case. If nothing has happened when you’re about to close the books, that money goes to profit”* (Respondent G).

Furthermore, it was found in the interviews that the risk assessment in the risk inventory does not have any direct connection to the risk assessment in the project book. It is up to the project developer to transfer any risks from the risk inventory to the project book if the risk can be valued in terms of money (Respondent B).

In the company's residential construction process, there is an estimation tool that provides integrated support for both the risk inventory and the budgeting of risks. Therefore, the system enables users to continuously assess different kinds of risks. The system provides users with the ability to perform a monetary assessment of risks by using input such as maximum- and minimum value, as well as probability of occurrence for each risk. Using that input, the system will calculate an expected value for each risk. In addition to this, the system provides support for assessing risks that are better expressed in a non-monetary manner. In the system, this is mainly the case for risks concerning health, environment and goodwill (or rather, negative goodwill). Such risks are graded by probability and impact, as was described previously.

While this system provides different tools for assessing risks, one respondent state that the system is not always used to its full extent. The same respondent expressed that, more often than not, developers use personal knowledge and intuition to value a risk, thereby taking a shortcut in the risk assessment; *"They decide that the risk is x crowns. They don't find out that it is x crowns because it's a y percent probability of z crowns"* (Respondent I). The respondent adds that it is not necessarily the wrong way of assessing risks since it serves the purpose of getting a contingency sum for each risk. However, it becomes difficult to analyze risks and get a better understanding of the uncertainty that lies behind different risks.

Assessing the cost of risks is done separately by the constructor and the developer. The respective assessments are then synchronized in meetings between the constructor and the developer to make sure that risks are not priced at both ends. If both the constructor and the developer would include a contingency sum for the same risk in their respective budgets, that could lead to a noncompetitive tender. One respondent states that *"The reason for having separate assessments is that you're involved in different steps of the process. The developer starts early. When we [the constructor] become involved we look more to the product and our economy. Then, you try to fit it together in the tender"* (Respondent H).

This also ties together with the purpose of risk assessment; as was expressed by some respondents, in order to most accurately price the tender, you need to translate risk into terms of money. The habit of translating risk into terms of money is further strengthened by one respondent; *"We, at the construction side, almost always put an equal sign between risk and money. Time is holy for the developer; We have to move in at that time"* (Respondent H). The belief that time, quality and cost is interchangeable was shared by several respondents. One respondent expressed that a short time plan leads to bigger costs, while a longer time plan leads to greater cost of capital. Thus, most risks that would affect project outcomes in terms of time or quality can instead be expressed in a monetary value (Respondent M).

The interviews showed that the previously mentioned methods for risk assessment, Probability-Impact and cost calculation were prevailing. In some of the interviews, Monte Carlo simulations were mentioned. However, only one of the respondents in this study had

first-hand experience with that kind of method. It became apparent that only a handful of these had actually been conducted. It was argued by one respondent that knowledge regarding Monte Carlo simulations and its utility was not enough to make it more frequently used within the organization. Instead, it has become a tool mostly used when an external client requests extensive risk assessment (Respondent I).

Similarly to the process of risk identification, several respondents pointed out that successful risk assessment relies on the use of the different competencies that reside within the organization. One respondent stressed the importance of being a team player; to ask others for help when needed (Respondent G). Correspondingly, another respondent stated that, in order to be successful, you need to have a humble mindset and realize your own limitations. If you are not familiar to risks in some area, there is almost always someone else who is (Respondent K).

### 5.4.3 Risk Mitigation

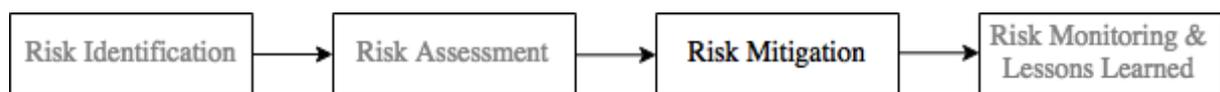


Figure 13 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

Risks are mitigated using several different strategies to either minimize the impact of the risk or to eliminate it completely. Even though there is no single solution to all risks, one respondent listed several of the more common strategies: *“What can we do to minimize or eliminate these risks from start? We can both switch production method and work through the different risks and eliminate the risks. Or we can transfer the risks. For instance we can transfer our risk to [the opposite party]. Can be that they don’t want to pay for it and we don’t want to bear the cost. And they are willing to pay for it since they don’t believe that it will realize... Or you can give it a monetary value and provide it in the tender. Then one can do several different contractual relations.”* (Respondent H). The same respondent elaborates by saying that since risk consist of many small fractions, the risk mitigation strategy consists of many small action plans. Another respondent provides similar insight. *“If we can’t do anything about it [the risk cost] we have to start tearing apart the method. If one has lost time in a project you can’t retrieve it. Instead you have to understand HOW we can solve the problem.”* (Respondent R).

Within the risk inventory established by both the developer and contractor, all identified risk (if deemed as a risk, based on the probability and consequence) are required to be supplemented with a workset. The risk inventory allows the project group to have a system where the responsibilities for a certain risk are documented. Then the process allows the one responsible to involve experts to mitigate the risk. A respondent (Respondent I) emphasizes that risk mitigation are needed to secure the correct quality. If a risk is identified, the project needs to ensure that the proper investigations are conducted to reach some

clarity regarding the risk, and that the investigation needs to be continuously updated. The respondent also reasons that a proper workset allow the organization to get insight on the specific risk. One respondent mentions that even though some risks are not given a monetary value, they can cause a negative ripple effect on the rest of the project. And the risk inventory allows them to focus on mitigating those risks and focus on the correct things (Respondent K).

However, one respondent says that the risk inventory is not always properly used. The reason given is that historically there have been a lack of resources and time but it is a lot better today. And they are “living” documents that need to be continuously updated (Respondent L). Another respondent says that there is a mindset when conducting the risk inventory the risks postponed to be handled at a later stage: *“There are flaws, often you postpone it and you end up with action plans saying that this is handled during production.”* (Respondent S). Instead the respondent stresses that it needs to be mitigated at an earlier stage.

One of the respondents discussed a different aspect of risk mitigation: accepting it. The respondent points out that the company needs to be aware of risks and use it to create business opportunities. The respondent emphasizes that on a normal market, the project have a specific price (price of project plus a risk premium). A company that has the resources and knowledge can therefore find more projects if they know how to mitigate the risks successfully (Respondent M).

Almost all respondents’ answers indicate that it is in the early stages of a project that risks are mitigated. *“There are no shortcuts and you can’t just shorten the timeframe [in production] Risks needs to be handled earlier in the planning stage.”* (Respondent G). Most of the respondents also emphasize that this is when risk mitigation strategies have the most impact since it is in the initial step of the process the project concept is developed. To ensure that the project is buildable several respondents talk about the importance of using the predetermined building parts available; since they are provided by experts within different fields and are established using both lessons learned and best practice. One respondent says that to successfully mitigate risks one cannot provide a design that is not even buildable. Then, the developer does not consider the impact such a design can have (Respondent G).

Apart from the predetermined building parts, several respondents also mention the importance of involving different experts. The company has specific support units that work with the more complex parts of a construction projects. Regardless if it is related to technical solutions, installations or procurement, several respondents stress the importance of really using the competence available both in-house and out on the open market. If the experts are properly involved, then the risks can be mitigated in an early stage of the project. One respondent state: *“I had a previous co-worker saying that regardless of what problem one has the solution is at most four phone calls away.”* (Respondent K). However, one respondent says that

even though the risk is assigned to a different unit or expert, one of the project members is still the one responsible to ensure that the risk is successfully mitigated (Respondent K).

The importance of collaboration is highlighted in several of the interviews. This is an area that have previously been lacking. Many of the respondents mention that historically, the two different organizations did not cooperate properly. However, respondents from both the developer and contractor emphasizes that this has changed over the last couple of years, and there is now a more a collaborative process between the organizations. The topic is stressed by one of the respondents talking about the importance of openness and honesty to successfully minimize risks and maximize opportunities. The same respondent also talks about both organizations needs to examine themselves while asking the rhetorical question: *“Are we [the developer] deciding on a cost-efficient product? Maybe not enough.”* (Respondent N). The importance of collaboration is also stressed by a respondent from the contractor: *“With our in-house developer we are involved from the earliest stages. We have a responsibility to contribute with our competence... One has to raise warning flags... Wave the flag and warn our customer.”* (Respondent R).

One of the respondents discussed how one could be influenced on how the risk management process works in different industries. That the construction sector has to think outside-the-box in order to improve and develop. The respondent made comparisons to insurance companies that gather all available data about their customers and use only the data when calculating their insurance premiums, which in reality is the insurance company’s risk exposure. (Respondent N).

Even if risks are identified in a later stage, when the product cannot be altered, they are mitigated using the same procedure. They are identified and assessed in the risk inventory and estimation tool. Depending on the risk, it is mitigated through an action plan or a workset.

### 5.4.4 Risk Monitoring, Follow-Up and Lessons Learned

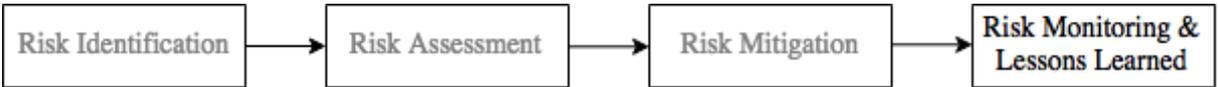


Figure 14 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012)

A part of the risk inventory created in the previous stages of the risk management process consists of a section where all identified risks are assigned to a project member. Even if the final responsibility lies with project manager, from the developer or contractor, each individual that is assigned a risk “own” that risk. That member is the one responsible for monitoring the risk and also ensures that the workset prepared is continuously monitored and updated if necessary. However, the company’s management system states that each

individual working within a project have a responsibility to work with risks and alert the designated project member if anything could happen. One of the respondents stresses that this responsibility cannot be ignored and that everyone have a personal responsibility, especially when there is risk of accidents or injuries (Respondent K).

The interviews conducted shows that the monitoring part is well-defined and clear. Once a risk reaches this step of the risk management process the responsibilities are divided (in the earlier stages) and the responsibility lands on either the developer or the contractor.

Even though the monitoring part is clear, almost all respondents' states that the follow-up and lessons learned part of the risk management needs to improve. The initial response when the topic of lessons learned in risk management is brought up during the interviews conducted share similar traits. The respondents states that this part is lacking, or that the company does not apply it altogether, or that there is huge potential of improvement. However, the responses show that the company works with the follow-up part. Most of the respondents say that risks are reevaluated and monitored before each forecasting period, which is also a requirement for the entire organization.

Risks identified in the risk inventory are followed-up on regular occasions. Even though there are no requirements, they are followed-up before each forecasting period when the project book and estimation tool are updated. The estimation tool is designed to allow easy monitoring and follow-up, but there are discrepancies between how it ought to be used and how it is used in reality. Once a risk is mitigated, the project members ensure that the result is sufficient and that the risks no longer have any probability to actualize. Once the project is finished, the project book is closed and any risk premium that has not been used increases the profit margin. There are uncertainties to what extent the projects realize this. The initial responses and reactions to the topic indicate that the company fails to follow-up the risks, but the responses to questions asked later on in the interview indicate the opposite.

The initial response when the topic of lessons learned are introduced in the interviews is that the company needs to improve. Regardless if the respondent is part of the developer's organization or the contractor's. The differences between the responses shows large inconsistencies to which extent lessons learned are utilized within the company. One respondent says that it is probably not done on a regional level but they discuss lessons learned within their own unit. While a different respondent thinks that it is done on a regional level but nothing they utilize in the projects.

One of the company's most utilized form of lessons learned is the predetermined building parts. The entire work process is created by projects identifying and mitigating risks. Once the project is completed, the support unit responsible for the predetermined building parts is informed of a proposed solution. The support unit evaluates the solution and then submits it to the intranet. When discussing lessons learned in the interviews, most respondents talks about the support unit and how their work helps the organization

minimize risks and increase the predictability in the projects. However, there are uncertainties to what extent the predetermined building parts effect the project outcome. One respondent discusses the correlation between the predetermined building parts and warranty costs: *“Now we build more with the predetermined building parts and the warranty costs should decrease. We don’t see any tendencies towards that”* (Respondent P). However, many believe that the predetermined building parts need to be utilized even more to get a better impact. It is indicated that repetitiveness and predictability help the project organization immensely.

Apart from the predetermined building parts, there are different forums where projects are discussed to better utilize lessons learned. The company’s Stockholm region installed a new discussion forum before the interviews were conducted. Several respondents have high expectations on the forum and believe that it will be a good solution to spreading useful information, and allow the organization to optimize lessons learned. The purpose of the forum is to share good experiences within the organization while also creating a collaborative environment. Respondents from the contractor say that they work with cross-project groups. This is where personnel with the same working title collaborate between projects, to learn from each other and share problems that might occur in their respective projects, and find solutions that might help.

One of the respondents said that the estimation tool can be further utilized (Respondent S). The tool can classify a project with crucial risks (garage under the building etc.) and other projects can use this to find comparable projects to benchmark their risk management process. However, only one of the respondents discussed this and it was stated that not many knew about this tool.

Before a project is allowed to enter the last tollgate, the project needs to gather the project group and perform a project evaluation. By many this is viewed as the main action where a project performs lessons learned related to risk management. Within the predetermined protocol used during the project evaluation, risks and opportunities are discussed and evaluated. There are respondents that believe that the lessons learned are not properly shared within the organization. *“We aren’t good at following-up our risks. If one identifies a risk and, as a fact, the risks is actualized we aren’t good at spreading the solution within the organization.”* (Respondent G). Another respondent stated: *“Don’t believe we have a collective approach to normal risks.”* (Respondent M).

The company is aware of the problems they have previously faced in regards to lessons learned. They have recently changed the management system to help the organization optimize their lessons learned process. The project evaluation format has been altered to incentivize the project team to share their knowledge. Now the focus is to if anything exceptional happened and how problems are solved. Each tollgate has also received a lessons learned part. When the project enters a tollgate there is a requirement from the

organization that they look at reference projects and share previous experiences within the project group.

A problem discussed in the interviews is that there are discrepancies on how risks are reported in reality, compared to how they are to be reported theoretically. Once a risk is mitigated, the risk is either actualized or not. Regardless, the risk ought to have a given result and the risk premium ought to be used in response to the risk or should be added to the project profit. However, the risk premium remains and is saved for a potential upcoming risk. The outcome is that one part of the project team identifies a risk and, instead of closing that risk once it has been mitigated, the contingency sum for that risk is “borrowed” by another part of the project team. This can create problems for the organization, since given risks cannot be tracked which creates problems for the organization to see exactly where all the risk premiums end up.

Reference projects are used as a method of utilizing lessons learned and is also required by the organization when passing through some of the tollgates. The purpose is to identify projects that have faced similar problems and apply their solution. This approach, however, is deemed as somewhat problematic; not specifically the use of reference projects, but one cannot be sure that the solution offered is the correct one. *“Our reference projects can be viewed as a successful project based on other aspects [i.e. large profit margin or satisfied customers]. But we can’t be sure the proposed solution is sufficient. We haven’t perhaps evaluated the solution properly...”* (Respondent T).

## 6. Analysis

*This chapter will provide an analysis and discussion of the findings. The analysis will be based on previously presented theory, but also discussed using the authors own reasoning.*

There are two different processes described within this master thesis. One being the project process that follows a tollgate system described in previous chapters. The second process discussed is the risk management process conducted to minimize risks and maximize opportunities. The purpose of this master thesis is to analyze the latter process. However, the risk management process is integrated in the project process, therefore the project process will also be discussed in this chapter.

### 6.1 The Risk Management Process

The company's risk management process is clearly described within their management system. The system sets the framework for how the organization ought to work with risk management on a both a group level, with the tender board, project- and business councils and the RFI process before a project is allowed to pass a tollgate. The management system also sets the framework on how the different projects are to work with risk management.

The risk management process on a group level exists to decide on the overall rules on how the company is to work with risk to ensure that all projects are profitable, minimize the company's exposure to unsuccessful projects and ensure that projects follow the company's business plan. There is a hierarchical structure for approval in the aforementioned RFI-process, where the executive board serves as the highest instance of approval. If a project reaches the executive board depends on the different project attributes; either the project reaches certain revenue or it is in advance deemed as either complex or risky. Further down the hierarchical decision chain there are project- and business councils, and regional boards that decide on projects with lesser revenue or lesser complexity (the different decision-making bodies are further referred to collectively as *boards*). This chain of commands is helpful as it allows the organization to make decisions at an appropriate level to smoothen out the process. Also, it creates a control function where decisions are approved by a manager's manager. The use of an hierarchal structure of approvement is deemed as a "must have" for a larger organization working in project form but with a centralized work process.

The different boards allow the organization to not only approve a project and allow it to continue through the tollgates. It also helps the organization to share knowledge and competence acquired from neighboring markets. This was discussed in one of the interviews where the interviewee explained that the boards receive hundreds of projects

each year. Therefore, they can help guide projects when faced with specific risks or uncertainties.

The management system provides all different units within the organization with proper tools and documents. One of these is the Heat Map, which stipulates how the different units ought to work in order to minimize risk within each project. The Heat Map is deemed to be useful for the governing body as it provides the business units with proper guidelines and ensures that the different business units meet the internal requirements to start a project. Even though residential projects are rarely, if ever, deemed as extremely uncertain or risky (in comparison to other large construction projects) it is important to note that there are internal guidelines used as a control function in case of any contingencies.

As the company work with a tollgate system that is clearly described within the management system, it allows the entire organization to know how a project is to be managed and what is expected by each individual when following the project life cycle. The data collected shows there are no uncertainties regarding the tollgate process. In all interviews, the tollgate system have been mentioned and often used to describe individual roles and how the risk is managed throughout the project life cycle. All interviewees describe the process in a cohesive nature which is expected since the project has to follow the different tollgates. When a project passes a tollgate, the project group provides the different boards with information regarding the project, as mentioned in previous chapters, and part of the information provided deals with risks and possibilities within the project.

Since the management system sets the framework for the project process, it also stipulates how the company ought to work with the risk management process. It describes how projects are to work with risks through the different tollgates and also which tools ought to be used, at what time during the process and to what extent in order to identify, assess, mitigate and monitor risks.

Even though there is a management system deciding the framework for both the project- and risk management process for all residential projects conducted by the company, there are discrepancies found when comparing the management system and the data collected from the interviews. The reason for this can be found in the academic literature. As several authors discuss, each construction project is viewed as unique and the final product is complex. This creates a mentality where there are no given answers in advance and the modus operandi for the construction industry is often to “reinvent the wheel” (Rezgui, et al., 2010).

Throughout the course of the study, especially when conducting the interviews, all of the involved parties discuss the tollgate system and project process. However, the risk management process is less discussed but for obvious reasons as it is an integrated part of the project process. But it is important to notice if the company wants to improve and lift the risk management process and create a larger awareness of it. This was discussed in one

of the interviews when asked how to improve the risk management process. The response was that the company needs to form a mindset and learning environment.

If a project is considered unique, it almost by default complicates the probability to utilize lessons learned from previous projects, as a solution from the unique project is not applicable to the next. However, this research is conducted on a residential development market where the project *processes* are repetitive and there are similarities between the *products*. This is important to note, since it allows for the company to use both lessons learned and best practice. The discrepancies found in the interviews are that there is a lack of cohesiveness surrounding the risk management process. This indicated that there are uncertainties on how risk ought to be managed. This will be further discussed when analyzing the risk management framework used during the interviews (risk identification, risk assessment, risk mitigation and risk monitoring). However, it is important to note that there are discrepancies and a lack of cohesiveness due to the practices of lessons learned and best practice.

Lessons learned is the concept of learning from previous experiences and adapt in order to develop. While best practice is when utilizing a solution and then evaluate to establish if it was the best solution or if the solution can be approved. In order for the two practices to be successful there needs to be full cohesiveness on what the optimal solution is and how that solution is to be utilized. This can be problematic since the individuals making these decisions have different backgrounds and experiences. This can be described with the different schools introduced in the literature. Based on the interviews it is apparent that risks are managed using three out of four different schools: the logical school, the subjectivist school and the behavioral school. The interviews also show that there are biases where there are a lack of repetitiveness and availability. Even though there is no interviewee explicitly stating there are problems with anchoring, it is a bias that is often apparent when working with people (Winch, 2010).

It is deemed that the problem that arises when lessons learned and best practice are clouded with bias and lack of coherence is that it can, unconsciously, create two separate processes. The first one is the explicit risk management process that is described within the management system. Within the explicit process all project members know how to act and how to manage risk within the projects. The interviews show that the explicit process is visible within the risk inventory, the project book and estimation tool, where risk are identified and quantified. The implicit risk management process, on the other hand, is utilized when there are no predetermined definitions or framework where the project member can use the specific tools and externalized experiences. When faced with such a risk, the project members need to utilize their own, and others, experiences to solve a potential problem. Almost all the interviewees describe that this is needed to solve problems as it is difficult to gather sufficient and comparable data. However, it is important

to note that this creates variation in both the implicit process and solutions based on lessons learned and best practice, as it is influenced by individual opinions.

Even though the bias problem was not explicitly discussed within the interviews, one interviewee discussed an important point related to bias. That is when one looks for comparative projects for solutions or help regarding risk management. The interviewee said that one often looks at what is deemed as successful projects. Although a certain project is viewed by the organization as a successful project overall (i.e. sound financial result or satisfied customer), the specific solution extracted from this project might not be suitable or even good.

The implicit process can be described as a heuristic approach to risk management which can increase the aforementioned bias and also create discrepancies between the process described in the management system and the process used in projects. It is important to note that this is not the absolute case regarding the subject company since there are many different tollgates and processes in place to ensure a cohesive risk management process. However, it is important to discuss that there are risk of uncertainties and discrepancies when faced with a heuristic mentality.

One interesting finding is that the heuristic approach is questioned in many of the interviews as the interviewees discuss the importance of collaboration and communication. This creates what can be referred to as joint risk management. Where both the developer and contractor take a holistic view on the project, rather than focusing on their own respective part. In order for this joint risk management to be successful, the organization needs to be both flexible and controllable at the same time (Osipova & Eriksson, 2013). This means that the organization needs a proper balance between the implicit and explicit risk management process; a too controlled organization will prohibit joint risk management. While a too flexible organization disjoints the involved parties in the project process. Therefore, the organization needs to be both controllable and flexible at the same time.

A flexibility within the organization and project process is important. The academic literature presents the concepts of either exploitation of knowledge or exploration of knowledge. Eriksson (2013) discusses these two concepts and introduces a coalition of the two called contextual ambidexterity. A concept where an organization that works in a project based format utilizes both exploitation of knowledge *and* exploration of knowledge. This correlates with the interview results which shows that the subject company needs to both develop the existing risk management processes and still develop the process itself. Meaning that even if there is a predetermined explicit process, the implicit process is necessary as the project members needs to customize it to fit the current project.

Many interviewees consider there to be insufficient information on risks, a lack of cohesiveness and almost no lessons learned, the interviews show that the risk management process is continuous through all stages of the project process. The different tools and the

tollgates are often referred to within the interviews, when asked to describe the risk management process. However, risks are also managed through a collaborative process, where project members from both the developer and contractor exchange experiences, both with each other and within their own organizations. This is clearly a possibility to utilize the concept of Early Contractor Involvement to a great extent. Mosey (2009) states that this can increase the collaborative elements of a construction project and that the contractor can identify production risks in advance. This is deemed as one of the company's major strengths. It also removes the principal-agent problem described by Winch (2010) and Ward, Curtis, & Chapman (1991); where risks are often transferred or allocated by the party least suited to do so.

Even though the contractual relationship between the developer and contractor is a design-build contract, there is a collaboration agreement between the parties with the purpose of eliminating any problems of asymmetric information. The agreement allows the organization to share all knowledge and competencies of both the developer and contractor.

The knowledge shared within, and between, the development unit and the contracting unit is a mixture of explicit and tacit knowledge. The purpose of this is to increase the awareness of risks so they can be minimized. The explicit risk management knowledge is shown through the aforementioned tools and other checklist and documents. Where the tacit risk management knowledge is generated through experiences. The interviews show that the believed solution to improve the risk management process is to transfer the tacit knowledge to explicit. However, this is not to be done by adding more tools and checklists. Rather by creating forums where risks can be discussed, and creating a mindset of pull-learning regarding risks; as this is can minimize problems within the industry (Santos & Powell, 2001). It is important to note that a qualitative approach to risk management is by many researchers viewed better than a quantitative approach (Edwards & Bowen, 1998) (Shen, 1997). That is somewhat contradicted by Wood & Ellis (2003), explaining the reason for quantitative approaches not being used within the construction industry is because of the skepticism towards it actually working. The same skepticism is found within some of the interviews.

Even though a majority of the interviewees believe that risk management is based on implicit knowledge, they do not believe that it is the implicit process that needs to improve. Instead, it is the explicit process that needs to improve to create a coherent way of conducting risk management. One of the respondents stated that the solution is almost embarrassingly easy. Everyone just needs to follow and document risks according to the risk management process instead of doing what an individual perceive is correct. An interesting reference have been made to the risk management process conducted by insurance companies. Where they are able to gather relevant data about the insured and calculate a risk premium based on the data at hand. This shows that there is a willingness

to differentiate the risk management process towards a more quantitative process. However, there have been recent changes within the organization. One is the aforementioned discussion forums created in order to spread implicit knowledge.

One would believe that the data would show that it would be the implicit process that needs to improve as this is where many of risks are managed according to both the interviews and literature (Edwards & Bowen, 1998) (Akintoye & MacLeod, 1996). And that is what have been altered by the subject company in order to provide a knowledge sharing environment. This is likely a result of previous misconceptions within the industry as risks are a somewhat fuzzy subject.

The collected empirics, interviews and observation shows discrepancies and that there is a lack of cohesiveness regarding the risk management process. However, it is not regarding how risk is identified, assessed, mitigated or monitored. All the interviews show that these are covered. The differences identified in the interviews are to what extent the predetermined risk management process is followed as it is not as described as the project process.

Finally, it is important to note that both the developer and contractor reside within the subject company. This creates an interesting notion on the relationship between the two. Even though it is the same company, they have separate risk management processes and the contractual relationship between the parties is design-build. Furthermore, the company share management system, tools, knowledge and experiences. Thus it creates an interesting relation. Where there is vertical governance between the company and its developer, vertical governance between the developer and the contractor, and horizontal governance between the company and its contractor (Winch, 2010). Based on the literature, this can create irregularities in the correspondence between the contractor and the company.

## **6.2 Risk Identification**

The process of risk identification differs throughout the different stages of the construction project. Early on, in the concept development phase, risk is mainly identified based on the experience and intuition of the project developer and the response is to a given risk source (Winch, 2010). Because of this, the risks identified at this stage could to some extent vary depending on which project developer is in charge of identifying the risks. Thus, risk identification can be considered a subjective process.

In the earliest stages of a project, when detailed design has not yet commenced, the process of risk identification is perhaps most difficult. As was evident from several interviews, revenue- and cost influencing factors are usually considered as most important when identifying risk at an early stage. The reason is that in the early stages, there is little information regarding the project, and risk shows the absence of information over time

(Winch, 2010). While still being important, time and quality is less prioritized when identifying risks in the early stages of a project. The reason for this seems to be that, in order to actually get clearance to initiate a project, the budget has to be satisfying the required rate of return. In regards to that, cost and revenue is crucial; time and quality, on the other hand, is not specific enough until detailed design commences.

In order to somewhat standardize the risk identification process, checklists are used to pass the different tollgates of the project process. This complements the aforementioned experience and intuition that project developers initially rely on; by using checklists, the project will not proceed to the next phase if any obvious risk factors have been identified. Even though checklists are not able to capture the uniqueness of different projects, it can be considered as a simple, yet effective, tool for raising the awareness of certain risks in projects. If the checklist indicate that the project might incur certain risks does not necessarily mean that the project will be stopped. Rather, it requires a need for contingency plans in case the identified risks should actualize.

The combination of personal experience and checklists is a way to utilize both tacit and explicit knowledge, thereby minimizing the downsides of each method. Personal knowledge provides flexibility which is favorable when dealing with heterogeneous projects. Checklists, on the other hand, ensure that systematic errors are avoided. Apart from the checklists other techniques such as brainstorming are described as a useful technique used when identifying risks also described in literature (Lyons & Skitmore, 2004).

As the project moves forward, through the different stages, new risks might be identified. This could be either because of alterations to the product, or because of alterations to the project team.

The most notable alteration of the project team is the involvement of the contractor; while the project developer might have focused on identifying risks regarding cost and revenue in the early stages, the contractor will be able to provide more information regarding any construction risks. This strengthens the theory regarding early contractor involvement. With the knowledge of a competent contractor, risks regarding the actual product can be more accurately identified. Mosey (2009) state that there are discussions whether or not a contractor is to be viewed as a full-fledged project member or not. Within the subject company this is mandatory and therefore the question is rendered moot in the internal work process.

However, implementing this in reality is more complex than it might appear. More precisely, it would require the contractor to be involved as soon as the project developer comes in contact with the municipality. Since the municipality has certain requirements on the built environment, the project developer would have to consult the constructor before proposing a concept to the municipality. As soon as the municipality agrees on a proposed project format, it becomes difficult to impose changes to the product. As was evident from

the interviews, there is a general opinion amongst the constructors that the developers sometimes promise the municipality too advanced products. Subsequently, the constructors have fewer possibilities to identify risks before the concept has been established.

The overall idea of utilizing different competences within the company in order to successfully identify risks is emphasized by most respondents. While some respondents express that the collaboration between different parties is lacking, it can be found that collaboration is, in many aspects is indeed very functional and effective.

In the later stages of the project process, there are fewer possibilities for alterations to the product. By the time production starts, most risks concerning the actual product should have been properly identified. If risks were to arise during the production phase, these will generally have to be handled in a reactive manner in order to remedy the situation. Wherein the risk isn't a response to a predetermined source, but instead to an event (Winch, 2010). Since there is less room for alterations to the product during the last stages of the project process, less time is devoted to identification of new risks. Even though many project members agree that the risk inventory should be continuously updated throughout the entire project, this process is lacking; the cause of this seems to be a lack of time and resources.

From the interviews, we can conclude that the identification of risks is no longer an active process as soon as the product has been successfully sold to the end customer. Some argue that the project timeframe should indeed be considered as longer than that, though; not until the warranty has expired is the project really completed.

### **6.3 Risk Assessment**

While the severity of individual risks may vary greatly throughout a project, the assessment of said risks has a common attribute throughout the process; cost. While risk can affect different project outcomes in terms of cost, time and quality, it is apparent that it is, close to always, translated into a monetary value.

Expressing risk in terms of a monetary value seems to be an effective way of budgeting and preparing a contingency sum in case any risk would actualize. It also makes risk comparable between different projects since said contingency sum can be expressed as a percentage of the total construction cost.

However, expressing risk in terms of a monetary value is not always easily done. While construction risks mainly stem from variations in supply cost and can be rather simply quantified, risks such as market risk is more complex and not as easy to represent in precise numbers. From the interviews it was found that, as the project progresses, risks are more

accurately valued. Using estimates in the early stages is a necessity since not enough information is available to make any accurate valuations of risk (Winch, 2010).

Our findings indicate that experience and personal knowledge is the main tool for assessing risk in residential construction projects. While a few projects have utilized statistical models, such as Monte Carlo simulations, the majority of projects rely on simpler calculations for assessing risks. Academic literature provides a possible reason for not utilizing statistical tools when assessing risk. There is insufficient knowledge or competence on how to utilize the tools (Wood & Ellis, 2003). The reason for this seems to be that the knowledge of project members is considered as sufficient enough to assess risks properly, especially in regards to the purpose of risk assessment (Edwards & Bowen, 1998).

There is, however, one exception to the above. At the beginning of a project, when it is reviewed at the first tollgate, a Probability-Impact model is used to assess risk factors. This model utilizes a set of pre-determined attributes that could be sources of risk. For each of these attributes that can be applied to the specific project, a probability of occurrence is determined, as well as an estimate of its impact on the project outcome. By multiplying the probability and the impact of each risk, the risk can be assessed and prioritized in relation to other risks that have been identified for the project. Using this kind of scale provides an easy way for most parties to assess the severity of a certain risk and decide if, and what, countermeasures are needed. However, it only gives a vague indication of what that risk will actually mean in terms of effect on project outcomes.

As was evident from the interviews, there is somewhat a lack of integration between the different types of risk assessment. The Probability-Impact model used in the early stages is not directly connected to the risk assessment measures taken later on in the process.

## **6.4 Risk Mitigation**

There are no universal tools to mitigate risks as several of the respondents stated. However, there are useful tools and techniques that are either qualitative or quantitative. The interviews showed that the choice of mitigation strategy varies with the risk itself. One interesting response given during the interviews regarding risk mitigation is that one has to truly understand *how* and *what* a risk really is. Winch (2010) defines risk as absence of information when a decision ought to be made and the absence of information can trigger an unexpected event. Some of the respondents talked about this and that one has to really dig in to each risk to truly understand all uncertainties. The project members need to break down every risk to fractions and form strategies based on that. That means all members needs to understand how the risks affects the project in order to mitigate the risk (Banaitiene & Banaitis, 2012). One large problem when there is no universal tool and the

solution is individual analysis is that the solution becomes subjective. This would not be a problem if the one deciding how to mitigate the risk is also the one performing the mitigation strategy, as this would not create the same uncertainties. However, this is not always the case within the construction industry where, for instance, a project manager decides on a mitigation strategy on a production risk and it is the contractor that has to perform the actual action.

Many of the risks are solved using some collaborative element where competences are used to find the best possible solution. This is also considered the common approach in previous research (Edwards & Bowen, 1998). An identified risk that is deemed to have a large or crucial impact on the project needs to be treated sufficiently. The project group consults either in-house or outside competences to dive deeper in to the risk itself. By involving experts within a certain field the project group can receive proper guidance on how to mitigate a risk.

Several of the respondents says that it is the earliest stages of a project that risk can be successfully mitigated. Within the literature this is referred to as risk avoidance. In this stage, the project concept is developed and it is easier to alter the product before a detailed plan have been decided. The use of predetermined building parts, guidelines and collaboration are some of the risk mitigation strategies several of the respondents discuss when talking about risk mitigation in the earlier stages of a project. Once the project moves through the project cycle, and the product cannot be altered, many risks are mitigated by creating worksets for each specific risk.

However, there are mixed signals if the risks are sufficiently mitigated in the earliest stages. Several respondents discussed that when a concept are over-designed it create risks in later stages. At the same time, the company needs to build a variety of products to satisfy all stakeholders.

The problem when using experience to solve issues are different types of biases that create an implicit and an explicit risk management process (previously described in this chapter). When mitigating a risk, a specific problem may arise, namely shirking (Winch, 2010). Even if risks are within the subject company identified by both the developer and contractor, the risks is “owned” by the developer but are transferred to the contractor. The shirking problem arises as the developer are unable to know if the risks are truly handled by the contractor. To solve this, the developer needs to ensure transferred risks are properly mitigated and demand proof from the contractor. The management system provides information on how this is to be done, via meetings and other control functions during the process.

There are uncertainties to what extent problems are solved properly is questioned throughout the process. Several of the respondents discussed that even though there are

available tools, the project needs to provide strategies on how to mitigate risks; otherwise these documents tend to “die” during the process. In other words, they are not updated continuously as they should have been. This creates a problem where risks can be missed as the documents are insufficiently updated. If the documents are not updated, it is hard for members of the project group to know if a risk is still relevant or not. It is about creating an awareness of all the risks to the project members can work with them.

The solution to these discrepancies are to further increase the collaboration between the developer and contractor. An identified problem with risk mitigation is that there needs to be full awareness on how ones action affects the counterpart (Banaitiene & Banaitis, 2012). Regardless if risks are mitigated using both a qualitative and quantitative approach there needs to be full trust between the parties and an honest dialogue.

The results from the interviews shows that the projects works continuously with risk mitigation and there are numerous worksets in place to minimize the risk. The management system provides an array of different and appropriate tools for mitigating risks. The problem seems to be that the tools are used inadequately and inconsistently.

## **6.5 Risk Monitoring and Follow-Up**

The risk monitoring process is considered straightforward. Once a risk is to be mitigated it is also assigned to an individual to monitor the risk throughout the process. The problem that occurs is when the risk is owned by one party and are to be mitigated by another. The interview shows that this is not a real problem within the subject company but several respondents implied that this needs to be followed-up thoroughly. The problem that occurs is not that the risk is improperly monitored. The problem arises when the one monitoring does not truly understand the impact that can happen with a specific risk.

Many of the risks are identified in the risk inventory that provides a probability and impact. Since the interviews describe a problem with updating the risk inventory then this can generate uncertainties regarding the risk itself; thus making it hard to monitor. For instance, a contractor can focus immensely on monitoring a specific risk that is assumed to be high by the developer (in an early stage). The problem related to the available tools are that they differ between the contractor and the developer. For instance, they use separate risk inventories which creates uncertainties not only when monitoring risk but also within the earlier stages of the risk management process.

A different problem that have been identified regarding risk monitoring is when the company produce their quarterly reports. Before each report, risks and opportunities are to be updated as they alter throughout the process. This is not done universally and differs between projects. The underlying problem was discussed in one of the interviews; that risks

tends to lag or even be saved once a risk is actualized. Then, the risk is instead used as a buffer for a different risk. This contradicts Winch (2010) concept of risk over time. Theoretically, a risk ought to be greater in an early stage of a project as there are less information and problems may arise in a later time period. In extension it means that risks ought to decrease as the project progresses. Instead, it is found that risks are constant throughout a period of time.

One additional problem found is the lack of documentation of risks. The problem is not that risks are treated inadequately. The organization can still perform lessons learned on the knowledge generated when solving a problem, thus improve the qualitative risk management process. However, the organization will have problems improving the quantitative process.

Most of the respondents replied that the company fails to work with lessons learned within their projects as many of the risks is described to reoccur. When overviewing the reoccurring risks some are expected to return and are mentioned by one of the respondents. For instance, there are always uncertainties regarding soil work. However, there seems to be an initial consensus that the company fails to work with lessons learned and spread solutions within the organization.

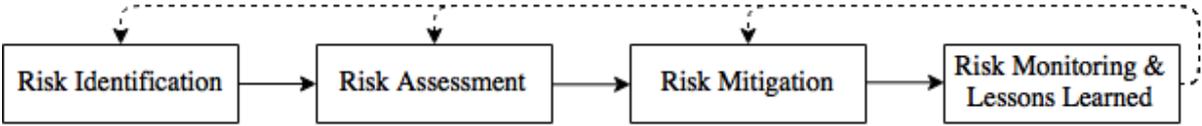
The interviews show that the company work continuously with lessons learned regarding risk management. Throughout the entire process, the collaborative element is present and experiences from previous projects are used continuously. When a project reaches a final tollgate, the project needs to submit a project evaluation where a part of the evaluation relates to risk and opportunities. The documentation is then submitted to the management system developers who have a responsibility to submit the content to the organization. The contractor also has cross-project group-meetings where positions (project manager, production manager etc.) from the contractor (operating in separate projects) discuss and evaluate problems and solutions. Moreover, within the Stockholm region, the company have focus-meetings where the developer and contractor discuss good examples from successful projects.

# 7. Conclusions

*Based on the previous analysis and discussion, this chapter will present the most important findings and their implications. In addition to this, recommendations for improvement are suggested to the company, as well as recommendations for further studies in the subject.*

This study has shown that risk management within the construction industry relies on two separate processes. One being the implicit process that is based on experience and personal knowledge of individual project members. The other being the explicit process described within the management system and internal documents. This study shows that both these processes needs to coexist. If only the implicit process is used it can cause large variations in the risk management process, and on the contrary, if only the explicit process is used then the organization cannot ensure that experience and knowledge are utilized as the explicit process is based on best practice and lessons learned.

Because of the reliance on personal knowledge and experiences, it has been found that risk management is related to knowledge and therefore the company can to an extent be considered a knowledge organization, therefore the knowledge needs to be managed accordingly. To be successful in using both the implicit- and explicit- risk management process the company needs to apply organizational ambidexterity. Where the company provides a system that allows the project to both exploit knowledge (refining the explicit process) and explore knowledge (innovate and develop the implicit process). Even if a risk management process is a linear system where specific risks are identified, assessed, mitigated and monitored the knowledge generated cannot be viewed as such. Instead, knowledge generated is to be seen as an iterative system where knowledge is constantly integrated in the risk management process. Hence knowledge is both exploited and explored.



*Figure 14 Risk management model. Author's own adaptation of Banaitiene & Banaitis (2012) and Eriksson (2013)*

Having a risk management process that relies on experience and personal knowledge is not necessarily negative. Since it has not been within the scope of this study to compare the outcome of experience based risk management with statistical methods, such as found within the insurance industry, no conclusions can be extrapolated in the matter. It could, however, be useful for the subject company to more accurately follow up the outcome of risk estimations. Creating statistics of risk estimations and risk outcome is motivated for several reasons: one would be able to find systematical errors in risk management, in order to provide a second-opinion on probability and impact of risks, and in order to improve

risk management through lessons learned. Risks tends to be both lumped together, which contradicts the responses received where interviewees believe a risk is divided in too many smaller fragments. Also, risks are described that they tend to have a time lag, where a risk remains within the project after it is either eliminated or actualized. Meaning that it is saved for further problems rather than used and a new risk is documented.

If used properly this does not provide a problem for individual projects. But it does create problems for more in-depth research on how accurate the risk management process is within the construction industry. Also it prohibits the use of a more detailed statistical approach to risk management.

However, since risk management within residential construction relies on the tacit knowledge of project members, the organization will benefit from creating an environment where tacit knowledge is best shared. This can be done in accordance to the SECI-model; tacit knowledge can be exchanged between individuals using socialization. Within the subject company, this could take the form of communities of practice – both formal and informal. Due to the inherent nature of informal communities of practice, management might not be able to control such settings. However, management can promote an environment where risk is communicated regularly by raising awareness of the subject. Moreover, management will be able to create and develop formal communities of practice by encouraging project members to share experiences (both positive and negative), and lessons learned in forums where members from different projects are present.

In addition to the above, it was found that project members prefer to contact other professionals when faced with a problem, rather than searching for a solution in a database. This behavior could also be promoted by encouraging socialization; when project members widen their network of contacts, as well as learn what others have done, they can more easily get in touch with someone who has experience from a certain situation. This also indicates that the use of pull-learning is preferred by project members.

One important aspect found during the study is the importance of utilizing the collective knowledge of all project members. This, together with the fact that uncertainties are generally greatest in the initial stages of the project, strengthens the arguments for using Early Contractor Involvement. By successfully applying that concept in a project, the process of risk identification and risk assessment is enhanced. In turn, this affects risk mitigation since risks can be avoided at an earlier stage; thus, not requiring countermeasures to the same extent.

Furthermore, the study has shown that risk management is, in practice, primarily used as a tool for budgeting the cost of uncertainties inherent to unique projects. While this is not explicitly stated by the company, it is still evident in the actual use of risk management. A

secondary purpose of risk management becomes to prepare contingency plans to counteract risk sources, thereby minimizing the cost for said uncertainties.

When it comes to project members' perception of risk management, all respondents in this study were aware of the process and considered it an important part of the overall project management process. Despite this, several respondents indicated that the risk management process was lacking in some, or several, areas. In contrast to this, the study found that while the self-perception was in some regards critical, the actual practice of risk management within the subject company was quite extensive. The company's implementation of different tools, in combination with the tollgate system, provides a rigorous risk management process. The discrepancies between explicit processes (i.e. management systems) and implicit processes (using personal knowledge and experience) might be the cause of this perception among project members.

The implicit and explicit risk management process are inevitably interconnected as both processes are used when the company identifies, assess, mitigate and monitor risks. Nevertheless, it is important to note that both processes exist when managing the risk within the company as (at the moment) the company cannot use only one of the two. If only the explicit process is to be used there is insufficient data available to support it. Such a system would require the subject company to have a database where x, y and z information regarding a project is submitted and a given risk premium is calculated. On the contrary, a fully implicit risk management process where all risks are valued based on experiences is risky in itself as it requires all project member to be experts within all fields (due to the complexity of the end product).

This study identified a problem when the risk management process is jointly explicit and implicit. That is the trustworthiness to the process itself. Throughout the interviews some respondents have discussed how the explicit tools is something the projects have to provide while others believe they work well. While many of the respondents believe experience and knowledge is the most adequate risk management tool it is important to note that these experiences can be biased (Winch, 2010).

The most obvious obstacles in regards to risk management is inherent to residential construction projects. Due to the long timeframes, from project start to finish, staff turnover is unavoidable – this leads to problems in maintaining continuity in risk management. In addition to this, the study has found that time- and resource constraints affect the active work with risk management. This sometimes leads to risk management only being performed periodically, rather than continuously, throughout a project. Only by prioritizing risk management more and raising awareness of its importance can the organization overcome such obstacles.

## 7.1 Recommendations for Further Studies

Since this master thesis has studied a single company in-depth, future research could determine the robustness of this study by comparing risk management between different construction companies and evaluate potential differences.

However, this study identifies the problem to track a predetermined risk through an entire project. As the risk alters and the risk is hard to document properly a recommendation for further studies is *to find comparable data*. Where the data, perhaps a specific risk applicable to all construction companies, is analyzed to compare how successful a construction company is working with risk management.

Furthermore, this study has not been able to compare risk management within the construction industry to risk management in other industries or business segments. Future research could dwell deeper into the subject and *benchmark risk management within different businesses*. For instance, it would be of interest to compare the efficiency of statistical methods with risk management based on tacit knowledge, as well as study what conditions and circumstances that makes the different approaches favorable.

## 7.2 Recommendation for the Subject Company

This thesis has studied the risk management process used when conducting a residential development in collaboration between the in-house developer and the contractor. These recommendations are based solely for the two units. However, these recommendations are, to some extent, also applicable to other construction projects conducted by the company.

Even if the empirics show that it is hard to document risk, the first recommendation is to *improve documentation regarding risk management*. The reason is that in order to increase the possibility to become more consistent and predictable in its risk management process, the company ought to document the assessed risk and, once eliminated or actualized, the risk outcome. By providing only one scenario and then document any divergence from the estimated outcome. This is to further sharpen the possibilities to assess risk in earlier stages and to improve the explicit process.

The second is to *strengthen the collaborative element between the developer and contractor*. All of the respondents discussed collaboration and early contractor involvement and how it contributes to successful projects. This is considered to be the company's main strength regarding risk management. Given that there is trust between the parties, *all* risks should be visible *and* discussed openly. This will strengthen a knowledge sharing culture which is needed to support the implicit risk management process that is an integral part of the process within the company.

The last recommendation is to *educate and use the tools available*. Even if the implicit risk management process is prevailing, the company have to focus on the explicit process as well. This is still a part of the overall risk management process and the empirics show discrepancies between how the available tools ought to be used and how they are actually used. If not done correctly, the trustworthiness of the tools will diminish and documentation of risks will become even more difficult.

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## **Table references**

*Table 1 – List of interviewees*

## **Figure references**

*Figure 1 – Antunes & Gonzalez (2015 (Antunes & Gonzalez, 2015))*

*Figure 2 – Winch (2010)*

*Figure 3 – Internal documents*

*Figure 4 – Banaitiene & Banaitis (2012)*

*Figure 5 – Banaitiene & Banaitis (2012)*

*Figure 6 – Banaitiene & Banaitis (2012)*

*Figure 7 – Banaitiene & Banaitis (2012)*

*Figure 8 – Banaitiene & Banaitis (2012)*

*Figure 9 – Internal documents*

*Figure 10 – Banaitiene & Banaitis (2012)*

*Figure 11 – Banaitiene & Banaitis (2012)*

*Figure 12 – Banaitiene & Banaitis (2012)*

*Figure 13 – Banaitiene & Banaitis (2012)*

*Figure 14 – Banaitiene & Banaitis (2012)*

*Figure 15 – Banaitiene & Banaitis (2012) and Eriksson (2013)*

# Appendix I.

## Interview Questions for Interview Round 1

### Inledande

- Vad är din roll?
- Vad är din yrkeserfarenhet?

### Generellt

- Hur arbetar ni med risker och möjligheter genom projektprocessen?
- Används några speciella verktyg för riskhantering?
- Hur värderar ni risker och möjligheter i monetärt värde?

### Samarbete

- Hur överförs risker och möjligheter mellan olika skeden i projektprocessen?
- Hur sker överlämnandet mellan arbetsgrupper?
- Hur fungerar ansvarsfördelningen kring riskhantering och den överlämning som görs i arbetsprocessen?
- Använder organisationen en gemensam riskbudget eller har olika parter separata riskbudgetar?

### Uppföljning

- Följer ni upp hur utfallet blev? Om Ja: Hur görs det? Hur ofta görs det?
- Hur ser du på förutsägbarheten i risker och möjligheter?
- Går det att bättre specificera risker för att underlätta uppföljning och förbättra riskhantering inför framtiden?
- Tar ni del av motpartens riskberäkning när de lämnar pris på en entreprenad?

### Övrigt

- Har du något mer att ta upp gällande riskhantering?
- Vad tror du är viktigt att fokusera på i ett examensarbete som hanterar riskhantering hos byggherre och entreprenör?

## Appendix II.

### Interview Questions for Interview Round 2

#### Inledande

- Kan du beskriva din roll, ditt ansvar och dina arbetsuppgifter?
- Vad är din bakgrund och dina erfarenheter?
- Vad är ”risk” för dig?

#### Riskidentifiering

- Hur identifierar ni risker i olika skeden av ett projekt?
- Hur överförs identifierade risker mellan olika enheter inom organisationen?
- Hur samarbetar olika avdelningar med varandra för att identifiera risker?

#### Riskvärdering

- Hur gör ni för att värdera risker?
  - Varför dessa metoder?
  - Har ni erfarenhet av andra metoder?
- Hur prioriterar man mellan tid, kostnad och kvalitet i riskvärdering?
- Vad är det främsta ändamålet med att värdera risker?
  - Värderar ni era egna risker (entreprenör/beställare) eller hela projektets risker?
- Påverkas er inställning till en given risk på omständigheter hos er motpart (beställare/entreprenör)?

#### Riskhantering

- Hur hanterar man risker?
- Hur prioriterar man olika risker i ett projekt?
- Vem ansvarar för att hantera risker?
  - Hur säkerställer man att det är rätt person som hanterar risken?

#### Riskuppföljning

- Hur följer ni upp risker idag?
- Hur kommunicerar ni kring risker i organisationen för att skapa medvetenhet?
- Hur tar ni lärdom av tidigare risker?

#### Potentiella förändringar

- Hur tror du man skapar en mer riskmedveten organisation?
- Vad anser du är det bästa sättet att förbättra riskhanteringen idag?

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