Risk Management in Sustainable Projects in the Construction Industry

Cases of Swedish Companies

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Abstract

Sustainable construction projects are expanding in the market and green codes and standards are advancing giving the ground for development of technology and materials applied. With every new material and technology utilised in the field, also risks are growing. The importance of risk management in sustainable construction projects is thus increasing and more experience and expertise is needed. So, the purpose of this thesis is to examine and gain deeper understanding of project related risks in sustainable construction projects in Swedish companies operating in built environment. It is crucial to gain knowledge of good practices within the industry to be able to propose further investigation of the subject that could improve the existing risk management and sustainable construction project goals.

This thesis examines the existing theory of the risk management process and sustainable projects by shedding light on the trends within the construction industry. The intention of the thesis is to add value to the existing gap in the theory that suggests that construction industry is exposed to more risks and uncertainty than perhaps other industries, and that introducing sustainability adds more uncertainties and risks. This phenomenon is claimed to be due to the lack of knowledge and experience in the area and, thus, practitioners seek for new ways how to tackle the arising issues. This thesis attempts to display how Swedish companies who are working with green and high performance buildings identify and deal with risks.

Two Swedish companies operating in built environment were chosen in order to investigate different ways of dealing with risks and the trend of sustainability in construction. Those in charge of risk and sustainability within the companies were interviewed applying semi-structured interviews and additional information was gathered through multiple sources, such as annual reports, web pages and other documents. This thesis has exploratory and qualitative research design and applies abductive approach for the purpose and the nature of phenomena.

The findings showed the different tools how risk management is applied in the companies and how it is related to the risks faced in green building construction. The results showed the importance of tools applied tackling sustainable construction projects that companies have applied and added to their processes in order to manage uncertainties that could occur if these processes were not implemented. As regards the generalisability towards findings, there still could be added more companies and future research could imply also maturity of the companies to make findings more precise. However, after consideration of the processes learnt from companies, the proposed model for achievement of successful sustainable construction projects can be followed and applied in other companies operating in this industry.

Keywords: sustainable construction, risk management, construction companies, project life cycle, green buildings, high performance buildings.
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1 INTRODUCTION

In this first chapter, we explain the background of the topic and try to describe the gap within the existing theory. From the gap detected we develop the research question and purpose of the paper, as well as the intended contribution we are hoping to deliver. The continued outline of the thesis is presented in the last subchapter of the introduction pointing out the main ideas of each section.

1.1 Background

On an international level, the construction industry is a major economic contributor within developed countries and is a rising market for developing nations (Eid, 2004, p. 2). Despite a slow-down in the rate of the productivity, the construction industry remains the largest industrial sector in the community, ahead of the food and chemical industries and it is crucial in producing investment goods (Eid, 2004, p. 20).

“Performance of a project has always been an important issue in the construction industry” (Pheng & Chuan, 2006, p. 25). Thus, it is crucial to understand what projects mean. Projects are the vehicles of beneficial change, and are about creating something that did not exist before (Økland, 2015). Projects are the way how construction companies essentially reach their goals and implement their strategy. Every construction project consists of specific phases that traditionally are covered in most of the literature available about the area of knowledge and these phases are seen in the model below.

![Figure 1. Project life cycle. (Archibald et al., 2012, p. 6).](image)

The model presented in Figure 1 outlines the typical project life cycle, however, project life cycle models that are presented traditionally are not fully covering the whole project’s extended life cycle, as they are missing out on the incubation or feasibility phase before the project initiation and the operation phase, after the close-out of the project, when it is crucial to evaluate the success of the project and its outcomes (Archibald et al., 2012, p. 6). Usually the phases following the project close-out are disregarded and not taken into the consideration of the project management overall plan.

Across the individual construction project life cycle, sustainability performance is an indispensable aspect in attaining the goal of sustainable development (Shen et al., 2007, p. 273). According to World Commission on Environment and Development (WCED, 1987) sustainability is commonly defined as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (cited in Bansal & DesJardine, 2014, p. 71), a concept that is accepted in many fields of study that include a sustainable approach. Thus, sustainability has been adopted by many companies through their mission statement and strategy (Sánchez, 2015), to cope with corporate objectives in an era that is demanding social and environmental
approach. Leading companies in different sectors are measuring and taking systematic steps to manage their sustainability impact; recognizing the way that a reorientation towards sustainable development is essential for ensuring their long-term viability.

Within the culture of the construction industry, sustainable development has been emerging as a new and important agenda for better practice (Eid, 2004, p. 3) defining it as the better utilization of resources and the creation of buildings with low environmental and social impact. The construction industry has successfully passed the milestone of recognizing the importance of integrating sustainable development into the core of the industry’s practices (Eid, 2004, p. 3). Creating sustainable agendas for the construction industry is a vital step towards a paramount change of this industry to achieve a sustainable future. Previous studies have shown that construction industry and its activities have significant effects on the environment and on people’s lives as well-developed infrastructure contributes to development of the society. In fact, the construction industry and the built environment are the main consumers of natural resources (Osipova, 2008, p. 1).

The construction industry represents a great potential for change because sustainable construction is about much more than the fabric of the built environment. As pointed out by Kibert (2013), in the early twenty-first century, the green building concept has won industry acceptance after being considered a fringe movement, and it continues to influence building design, construction, operation, real estate development, and sales markets. Green building concept is related to design and structure of the building that applies resource efficient techniques and ecologically based principles (Kibert, 2013, p. 8).

Despite the success of the green building movement in general, challenges arise when implementing sustainability principles within the well-entrenched traditional construction industry (Kibert, 2013, p. 25). The construction business develops in a continually turbulent environment. Sustainable construction development in this environment depends on two major drivers: the rapid advancement of scientific and technological progress; and people’s perception of project sustainability (Zhang et al., 2014, p. 67). As technology has blossomed, projects have increased in complexity and project management has proved to be an essential and vital tool for managing and delivering more successful projects according to planned time, cost and quality.

One of the factors that contribute to the success of the project outcomes is related to good risk management and risks detected that could impact project’s scope. Risk management is crucial part of the project management, and in the construction industry it is not an exception. The importance of it is increasing as projects often fail to meet deadlines or they overrun costs (Iqbal et al., 2015, p. 66); and if applied in an efficient and effective way, it affects the performance and success of the projects (Serpella et al., 2015). Construction projects are typified by their complexity and diversity, usually described as complex tasks where even a product of small size involves many skills, materials, and a great number of activities.

Construction projects are exposed to risks at the time of their inception. In the various stages, it should, first of all, be considered what risks are present, second of all, what measures can be taken and, lastly, how costly these measures are (Shcieg, 2006, p. 77).
For this, risks, possible risk costs, measures and costs of the measures should be identified and suitable measures should be found in order to avoid errors in the future.

Previous risk management investigations in the construction industry show that the most common risk management problems are related to the risk identification (Tserng et al., 2009, p. 996). Most construction companies conduct risk management based on previous experience rather than a formal risk analysis due to time and knowledge insufficiency; this phenomenon could increase due to the novelty of the green building movement.

Nowadays the world is demanding sustainable practices in every sector; as mentioned before, the construction sector being one the most resource consuming one, needs to thrive towards sustainable practices. Different risks are arising along the sustainable construction process, as this is a developing and evolving area. In addition, the common problems in risk management processes in construction, and a lack of research in the construction sustainability risk management area are opening the doors for further exploring the current state of the theory, and, moreover, the current practices.

Furthermore, risks at the operation phase are rarely mentioned and a special framework has not been established for it, however, the trend of sustainability is requiring to cover the construction projects at an extended life cycle. This thesis concentrates on the identification phase of the risk management process on an extended project life cycle when risks of the construction project can still evolve.

1.2 Research Gap

Risk management has been studied for a long time in projects, project management, and specially in construction projects. A lot of extensive researches have been undertaken in the field of risk management for construction projects recently. One of the major outcomes of these attempts are the identification of the project objectives related risks and the project phase related risks (Zou et al., 2007, p. 602). Risk in construction has been the object of attention because of time and cost overruns associated with construction projects (Akintoye & McLeod, 1997, p. 31). As stated by Iqbal et al. (2015, p. 66), the risk management process affects the outcomes of the projects; and as projects become more complex, an effective risk management should be applied.

As pointed before, the identification phase of the risk management is one of the most studied ones. This is because it is paramount to identify the risks related to the project in order to manage them and perform a solution or leverage accordingly. The identification of the risks becomes a problem when the construction projects are evaluated from a project life cycle perspective; nevertheless, as pointed by Archibald et al. (2012), an extended project life cycle perspective is needed to assess projects, as many risks in the operation phase need to be addressed.

Great amount of construction projects leave a lot of space for various environmental, socio-political and other unforeseen problems during conceptual phase, land expropriation, and execution leading to time and cost overruns in projects and compromise in quality. The cost overruns can be of a huge magnitude in a project involving large amount of money. Nevertheless, authors point out that many of the risk
management analysis in the construction industry are made using previous experience because of limited resources (Iqbal et al., 2015; Tserng et al., 2009; Kibert, 2013).

Even before introducing sustainability goals in construction industry, it is claimed that construction is exposed to more risk and uncertainty than perhaps any other industry (Flanagan & Norman, 1993, cited in Rafindadi et al., 2014, p. 457). Now that such goals are part of a growing trend in the built environment, it just made this industry riskier. Some authors (Kilbert, 2013; Nutter, 2007) point out the fact that the lack of knowledge and/or experience in this area prevents practitioners from identifying all the risks related to green building and high performance buildings. The literature about risk management and sustainability risk management has not been developed yet to help professionals in the construction industry to understand and identify the risks related to the application of sustainability in the construction processes and products. Anderson & Anderson (2009, p. 25), for example, set sustainability risk management in a corporate level; the literature related to this area merely points out that there are risks related to the sustainable principles (social, environmental and economic).

With all the described above, there is a gap between the sustainable construction practices current knowledge, such practices in sustainable construction are described by green building and high-performance buildings, and the related risk identification. Particularly in the operation phase, where new materials and/or systems may present performance failures. With most of these materials and systems being developed for specific projects there is limited experience and knowledge related to their performance; many practitioners decide to avoid the risks associated to this, nevertheless, many are using them. Also, it should be pointed out, that if specifications of the design of the building change from the “green” materials or systems to traditional ones, the sustainable goals are more likely to be missed.

This thesis focuses on Swedish companies operating in built environment, as Sweden has been ranked the “Most Sustainable Country in the World” in 2015 by a study made by RobecoSAM, which has had a big impact on how Sweden is perceived in such terms. Such study includes aspects like social equality, environmental response and renewable energy. However, construction industry is yet resistant to the changes related to sustainability even though the sector contributes to the global resource depletion considerably (Lorenz et al., 2008 cited in Persson, 2009, p. 24). All of the above, make Swedish companies a good object for this thesis in terms of sustainability.

1.3 Research Question and Purpose

The problem’s background and research gap have lead us to the following research question:

*How do Swedish companies, operating in built environment, identify and deal with risks associated to Green Buildings and High-Performance Buildings?*

The purpose of this thesis is to understand if construction companies that deal with sustainable construction in an environment that is demanding it, like the Swedish one, can identify the risks related to these practices, as they are constantly developing such projects. Furthermore, the thesis tries to examine, if those risks are identified, how Swedish companies deal with them without compromising the Sustainability goals of
the construction process and the sustainable final performance of the product; in this case, the buildings.

1.4 Intended Contribution and Delimitations

From a theoretical standpoint, we intend to provide a model that outlines the importance of the project phases as an extended life cycle in order to identify all the risks associated to sustainable construction. This should serve as a starting point to conduct more researches related to sustainability risk management in sustainable construction projects. This last, as sustainable construction is a growing trend that is shaping the construction industry around the world, thus, becoming more important.

From the practical standpoint, we aim to help professionals in the built environment to realize that effective and efficient risk management can be applied and must be applied in order to maintain the sustainable goals set for the projects.

Delimitations of this study are set in time constraints and number of companies interviewed. This study will be delimited in Sweden; however, it accords to the importance of the sustainability issue and Sweden is one of the countries where it is applied. No quantitative or statistical generalizations will be conducted in terms of success of the application of the concepts. Only qualitative research that supports the abductive approach taken in the thesis is applied in order to closely examine the opinions and understanding of the topic from the respondents’ point of view.

1.5 Continued Outline of the Thesis

The thesis starts with the first section that introduces the topic and its theoretical background. After the insight into the knowledge area the research gap is described and the aim of the research is stated, which is supported by the research question and purpose of the study. Intended contribution is pointed out in the first section as well as the delimitations that this research has established.

The second section deals with the explanation of the research methodology from the scientific point of view. It starts with laying out the philosophical considerations and assumptions impacting the research. In order to justify the choice of the methods applied in this research also the research design, strategy and approach are described.

In the third section literature review is conducted and it is built upon the logic of the framework further developed from the theories available in current literature. The section starts with the risk management that sheds a light on project risks as such, risk management techniques such as qualitative and quantitative ones. Furthermore, it examines the importance of the risk management in construction projects and finally describes the difference that sustainable risk management has with the traditional one. The second part of the section reviews the theory on sustainability related to the construction projects, challenges of sustainable construction and green building obstacles and economic factors are considered. Finally, the third part deals with the risks in green construction, thus, providing the elaborated model from the previous literature review of this thesis and explaining its essentiality.
Fourth section is dedicated to the practical methodology that portrays the criteria for the case selection and the semi-structured interview guide that is supported by the procedure undertaken for this thesis. Moreover, truth criteria and ethical considerations that guided the current research are stated.

Fifth section displays the empirical findings of Skanska and Sweco and the opinion of independent scholar and consultant of sustainable construction projects. The findings from primary and secondary data are explained and the overall situation of the current trends in the areas of interest are portrayed. Both risk management and sustainable construction methods applied with the companies are discussed and different kind of tools are then evaluated according to the application of new technologies and new materials.

Further discussion and comparison can be found in section six as well as conclusions and the proposed model from the findings in theory and companies. In this section the focus is on green buildings and risk management as this is the purpose of thesis as well. Moreover, the importance of the risk management’s position within the life cycle of the project is described for each company under discussion. Viewpoint of independent consultant then is elaborated while comparing both companies which gives the discussion another angle to look from.

The last section explains more closely the reasons of the new model and its implication for the further studies. It draws conclusions and recommendations for future studies. Furthermore, this section summarizes the findings and aligns it with the purpose of the thesis.
2 SCIENTIFIC METHODOLOGY

In this chapter the pre-conceptions and worldviews of the authors are clarified to further show how it has affected the research and data analysis. Research design method and strategy to implement it is stated in the further subchapters as well as data collection methods and the process of literature review.

2.1 Ontology

The ontology is a philosophical question people have about nature of reality (Saunders et al., 2009, p. 110). According to Bryman & Bell (2011, p. 32), therefore the central idea is “whether social entities can and should be considered objective entities that have a reality external to social actors, or whether they can and should be considered as social constructions built up from the perceptions and actions for social actors”. The two ways of thinking are objectivism and constructionism respectively.

This thesis paper takes constructionist viewpoint as risks can constantly change according to the regulations, to what social actors do and how they influence them. What we understood as sustainability years ago, and what it has become now is also made up from social interactions. Moreover, we intend to use social constructivism as our philosophical viewpoint as we are planning to interview employees of companies operating in built environment and we believe they apply meaning to situation under discussion and could provide us with direction to answer our research question. Furthermore, as researchers we are planning to interpret and analyse gathered results subjectively. In social constructionism, it is more common to use open questions as we are striving to understand also implication of respondents’ values and perceptions (Creswell, 2008, p. 8). As we are trying to understand the interaction between sustainability and risk management in projects, we believe that constructivism assumptions are relevant to this study and may enable us to see how the situation changes for different actors due to the environment or their positions, or any other factor coming from their side.

2.2 Epistemology

Epistemological question is concerned with the way knowledge is or should be acceptable within the area of interest (Bryman & Bell, 2011, p. 26, Saunders et al., 2009, p. 112). Moreover, Bryman (2015, p. 24) mentions that the issue should be related to the question “of whether or not social world can and should be studied according to the same principles, procedures, and ethos as the natural sciences”. Saunders et al. (2009, p. 113-115) distinguish between three main epistemological stances: positivism, realism, and interpretivism. Positivism research refers to “working with an observable social reality and that the end product of such research can be law-like generalisations similar to those produced by the physical and natural scientists” (Remenyi et al. 1998, p. 32 cited in Saunders et al., 2009, p. 113). Realism, on the other hand, shows that objects can exist without the interaction of human mind, similarly as the idea of positivism. Finally, interpretivism, as an alternative to two philosophical stances, implies the importance of understanding the difference between humans as social actors (Saunders et al., 2009, p. 116).
This paper takes interpretivism viewpoint as it relies on the knowledge obtained from the respondents and their understanding towards the risk management and sustainability issues. We believe that by examining the perceptions of respondents of the risk management and sustainability issue within it, we can interpret the results and generate the knowledge of the area, that it may help us to explain the notions under discussion. Even though we are looking at established processes such as risk management in the company as well, our focus is rather on the new trend of sustainability related projects and their risks that still can be interpreted from actors’ knowledge differently as it is not standardized process but rather acting according to the situation.

2.3 Axiology

Axiology refers to the roles that values play in the research and how it affects the results of the research. Saunders et al. (2009, p. 116) stress the importance of axiology as they believe that values are guiding reason for all human action. Therefore, we discuss our own values in this chapter and try to show how it could influence the research.

We acknowledge that our own values as well as our preconceptions of the topic may influence the research, as both thesis authors had initial understanding of the area of knowledge discussed in this paper due to the previous experience. Garrick (1999) sheds a light on the importance of the experience as the creator of our preconceptions which highly influence the way we identify relevant theories in order to find a solution for the problems we detect. Being aware of our values permits acknowledging any bias that could impact us as researchers and therefore we try our best to avoid it.

Firstly, we come from two different continents with two diverse backgrounds professionally and academically. The culture, knowledge obtained and experience has shaped us and reflects in the different ways how we think and act. We apply our diversity as a tool to detect and analyse problems from different perspectives. However, in this moment we are both Strategic Project Management students who have learned great deal about risk management and have been very interested in the field of sustainability and construction. Even though Francisco’s background is related to engineering and construction, it just helped us to identify the importance of the topic within the field. Furthermore, we have tried to untie ourselves from preconceptions as much as possible and concentrate on the knowledge gained through literature review.

2.4 Research Approach

The previous philosophies explain how we intend to use social actors and knowledge of the area, however, research approach allows us to clarify how we intend to use theory. Research approach is divided into three types: deduction, abduction and induction (Saunders et al., 2009, p. 124-126). According to Adams et al. (2007, p. 29) the inductive approach relies on the empirical verification of a general conclusion that comes from a defined number of observations, hence, it goes from the specifics to the general. On the other hand, the deductive approach goes from the general to the specific, essentially testing existing theories (Adams et al. 2007, p. 30). The main difference between deduction and induction is that one is testing theory while the other is building it respectively. Moreover, induction refers to collecting data that would strengthen or problematize the existing theory and deduction would in contrary have the hypothesis approach on the observations within the theory (Tavory & Timmermans,
2014, p. 5). The authors note that neither of the approaches is creative as they fail to lead to new theories.

Furthermore, abductive research is treated as the combination of both other approaches (Blaikie, 2009, p. 89). As explained by Adams et al. (2007, p. 30), in most research work it is necessary to use both approaches, as they tend to be complementary. Instead from moving from data to theory or vice versa, an abductive approach moves back and forth combining inductive and deductive (Sudabey, 2006; cited in Saunders et al., 2016, p. 148). Abductive approach is rather creative inferential process that allows to make new theories and hypotheses deriving from the evidence found in the empirical study (Tavory & Timmermans, 2014, p. 5). The theory about sustainable risk management is existing theory, however, the theory is not explored deeply and, thus, lacking a clear explanation and framework that could be applied and used within academic world and world of practice, thus, this research is taking the abductive research approach. It will help to explore the social actors’ language and meanings and from there construct theories or improve them (Blaikie, 2009, p. 89). Therefore, we are concentrating on explaining the phenomena from the point of view of the respondents and we interpret the knowledge, and try to answer our research question accordingly. We move back and forth in theory to see the existing patterns and develop new ones combining with the existing ones, thus, applying the abductive approach to the research.

2.5 Research Design

The three main research design types are exploratory, descriptive and explanatory (Saunders et al., 2009, p. 139-141). An exploratory study is a valuable mean for asking questions in order to find out what is happening and gain insight about the specific topics of interest (Saunders et al. 2016, p. 174). A descriptive study, according to Saunders et al. (2016, p. 175) is used to gain an accurate profile of subjects, situations or events whereas an explanatory one establishes relationships between variables within the study.

On the one hand, exploratory studies are particularly useful in clarification of an existing problem or simply assessing notions in new light, enquiring, seeking new insights (Robson, 2002, p. 59 cited in Saunders et al., 2009, p. 139). On the other hand, descriptive studies deal with data that researcher has a clear idea about before conducting the research. Robson (2002, cited in Saunders et al., 2009, p. 140) claim that descriptive studies are “to portray an accurate profile of persons, events or situations” and, thus, describe the concepts by applying the available theory. Lastly, explanatory research, as mentioned before, is the one that combines variables and explains the causal relationship between them (Saunders et al., 2009, p.140). This thesis uses the exploratory research design as it tries to explore the topic of sustainability in risk management and how companies in built environment deal with it. We try to explore the relationship and impact on companies while tackling possible risks within projects and how the general activities of organization are related to the sustainable risk management.

Another scholar (Creswell, 2008) mentions qualitative, quantitative and mixed methods for research as the part of its design phase. As explained by Saunders et al. (2016, p. 165) to differentiate between quantitative and qualitative is necessary to differentiate between numeric and non-numerical data. These methods simply explain the way
information is gathered and then discussed. Qualitative and quantitative methodologies can be interpreted through their associations to philosophical assumptions and research approaches and strategies. As explained by Adams et al. (2007, p. 26) a quantitative research refers to the one that is based on positivism principles, applied for quantitative measurement and thus statistical analysis is used. On the other hand, qualitative research is associated to an interpretivist philosophy (Saunders et al., 2016, p. 168). Qualitative research employs methods of data collection and analysis that are non-numerical, aiming to explore social relations and describe reality as experienced by the respondents (Adams et al. 2007, p. 26).

Qualitative methods include such data collection tools as narrative research, grounded theory, phenomenology, ethnographies, and case studies; while quantitative research design can imply tools as experimental or non-experimental designs such as, for example, surveys (Creswell, 2008). From the design methods in this paragraph we apply qualitative research method and explain the data gathered according to the worldviews previously mentioned as we are planning to collect non-numerical data and conduct interviews with open-end questions. We believe that qualitative research would allow us to explore more deeply and explain the research area, and give more valuable results to fulfill the purpose of the study as, by applying it, we can understand better why people act in certain ways and why they make certain decisions (Creswell, 2008). We combine qualitative research design with the worldviews stated above and believe that with this approach we could gain more valuable information and try to improve the knowledge area.

2.6 Research Strategy

Different research strategies can be applied that would help to answer the questions proposed in the research. “Strategies are types of qualitative, quantitative or mixed methods that provide specific directions for procedures in a research design” (Creswell, 2009, p. 11). According to Yin (2003, p. 5), each strategy can be used for exploratory, descriptive or explanatory types of researches. Exploratory strategy deals with unstructured or semi-structured interviews and in-depth analysis while descriptive one is rather categorization of the data, and explanatory describes the relationship between concepts or variables within the area of knowledge (Saunders et al., 2012, p. 170-172). When deciding between the strategies, it is closely linked to the methods used in gathering the data. Strategies proposed by Saunders et al. (2009, p.141) are experiment, survey, case study, action research, grounded theory, ethnography, and archival research.

Creswell (2009, p. 12) lists the five strategies most widely used for qualitative investigations: narrative research, phenomenology, ethnographies, grounded theory and case study. According Saunders et al. (2016, p. 197), narrative research seeks to keep chronological connections and the sequence of events as told by a subject to enrich understanding and aid analysis. Ethnography is used to study a group’s culture and social structure from the perspective of a subject within such group (Zikmund et al. 2013, p. 138; Saunders et al., 2016, p. 187). Grounded Theory refers to a methodological approach that develops theoretical explanations of social interactions and processes, therefore aiming to build theory based on data produced from social actors (Bryman and Bell, 2011, p. 576; Saunders et al., 2016, p. 193). “A case study is an in-depth inquiry into a topic or phenomenon within its real-life setting” (Yin, 2104;
cited in Saunders et al., 2016, p. 184). This research applies ‘case study’ technique as we believe that it would allow us the best to explore the topic in-depth and allow to understand the applied theory better from the respondents’ viewpoint, thus using exploratory strategy for the research.

“Case studies are used to study particular phenomena in particular settings” (Adam et al., 2007, p. 112). As suggested by Yin (2013, p. 2), case study is a good way to explain present circumstances that derive from inquiring the knowledge area with open-ended research questions (‘how’ and ‘why’ social phenomena functions). Case study can differ from multiple to single case studies and as we are aiming to discover the context and processes within the area of knowledge, we use interviews as our main data collection tool. Context, complexity and ambiguity is best discovered via case studies and, thus, it offers more holistic and systemic approach (Gummesson, 2007, p. 229). As stated by Adams et al. (2007, p. 112) case studies are very common in business research and useful for conducting an analysis of an organization. “It is rooted in the observation of empirical data and can be used, within some prior established limits, to evaluate the efficacy of theoretical frameworks” (Adams et al., 2007, p. 112).

By conducting interviews within construction industry, we are expecting to construct the context and build the multiple-case study that could further be applied in other similar companies within the industry of construction and/or countries. However, we bear in mind the theory and concepts that already exist in the available literature of the sustainable construction and risk management and we try to explore from different perspective if the phenomena are true by applying semi-structured interviews. Multiple-case study would help us to explain the proposed model and improve it from the practitioner's’ point of view.

2.7 Literature Search

Management theories, especially in the construction industry have been studied for a long time now. Project risk management and sustainable construction projects are broad topics so in order to gain the best possible literature review, some of the books within the area of interest were examined to get clearer idea about the topic. The main authors in the field of risk management, sustainable construction and sustainable risk management were identified and the next step was the search for the articles related to the area of knowledge, using search engines provided by Heriot-Watt University and Umea University. Journals as The Project Management Journal, The International Journal of Project Organisation and Management, The International Journal of Project Management, The International Journal of Managing Projects in Business and The Journal of Civil Engineering and Management were consulted for the main topic of the thesis. The main databases where the articles were found were Elsevier, ScienceDirect, ASCE Library, Taylor & Francis Group, etc. The search was conducted using the following key words: risk management, risk in construction projects, sustainability, sustainability in construction, sustainable risk management, green construction, green construction technology. Additionally, journals and books were used in order to define the method, methodology and research strategies and design of the thesis. Articles and books were gathered in F1000 software and used for keeping all the articles in one database.
3 THEORETICAL FRAMEWORK

In this chapter, we discuss, in more detail, the theories and concepts related to our research question and purpose. We begin by defining and describing risk management and its techniques, further explaining risks in construction projects and describing sustainability risk management. Later we introduce the term Sustainability and explain the concepts and challenges within Sustainable construction. We explain which are the risks in green construction as part of the sustainability construction. Further we present a proposed model that describes the gap between sustainable construction projects and construction project risk management.

Risk management and sustainability are the main concepts that help to answer the research question proposed. These concepts are quite separate in their meaning so this thesis intends to shed a light on the risk management separately from sustainability and in the end combines the two concepts into sustainable construction risk management theory. It is essential to explain and acknowledge both terms as their specific characteristics are the ones that build up the proposed model in the end of theoretical framework chapter.

3.1 Risk Management

3.1.1 Project Risks

To understand better what risk management refers to, further concepts related to it should be explained to point out the differences and misconceptions between them. According to PMBOK (2008, p. 275), “the projects’ risks are events or uncertain conditions that, in case they happen, they provoke a positive or negative effect in project objectives”. While PMBOK includes all the three concepts within an explanation of risk, different scholars mark the differences between them. For Ward and Chapman (2011, p. 70) risks are “possible unfavourable outcomes”; Cooper et al. (2004, p. 3) goes further and states that risks are “the exposure to the consequences of uncertainty”. This definition of risk is the most commonly accepted in practice, as risks are unfavourable or negative events that can occur during the project life cycle.

Opportunity can be described as a ‘possible favourable outcome’ (Ward & Chapman, 2011, p. 70). Moreover, opportunity is basically the opposite factor of the risk and could be tackled in different ways, thus, it should also be included in the identification phase and should be leveraged. Furthermore, opportunity may turn into threat and vice versa if the necessary action has not been taken (Caron, 2013, p. 52), which also gives another reason of the importance in the identification of both, positive and negative risks.

According to Floricel and Miller (2001, cited in Caron, 2013, p. 8), the traditional project risk management covers only the uncertain area of the events occurring, excluding the certain and unpredictable events. Therefore, certain events stand for issues and/or benefits, uncertain events are risks and/or opportunities and unpredictable events are the unforeseen ones (Caron, 2013, p. 8). Ward and Chapman (2011, p. 69) describe uncertainty as merely a ‘lack of certainty’ related to the goals of a project and how those goals can be achieved. However, this thesis views uncertainty as described in
the PMBOK (2008, p. 275): “a condition that causes favourable or unfavourable outcomes”.

According to PMBOK (2008, p. 275), two types of risks are distinguished such as known risks and unknown risks. Known risks are the ones that can be identified and their response plan can be developed, similarly to preventive actions that should be taken before the occurrence of the risk. Whilst unknown risks stand for the ones that cannot be managed proactively and they require contingency plan (PMBOK, 2008, p. 275).

Risks can be measured by the probability of occurrence and by the impact they have on project outcomes (Cooper et al., 2004, p. 3; Flanagan and Norman, cited in Zou et al., 2007, p. 602)). Therefore, risks should be identified and assessed, dividing them into different categories, such as: major/residual, specific/systemic, insurable/not insurable, controllable/uncontrollable, tolerable/intolerable (Caron, 2013, p. 60). Major risks are the ones that should be assessed separately and have individual response actions while residual ones are all addressed with contingency reserve. Specific versus systemic risk differs in how many projects the risk is affecting, for example, pound’s devaluation affects a set of projects - systemic. Insurable risks are literary risks that can be insured, for example, fire safety of the building; in contrary, other risks should be managed by project team itself. A risk is controllable if it has a possible response action plan (at least mitigation), and the cost of response action implementation does not exceed risk exposure. Tolerable risk refers to the maximum tolerable loss of the project (its budget, etc.) (Caron, 2013, p. 60).

The risk management process within a project is essential to ensure the achievement of the project goals. Any possible event, risk or opportunity, need to be managed in an efficient way to avoid unfavourable outcomes or to enhance the expected ones. This thesis concentrates on events that represent risks, therefore, unfavourable outcomes for the project.

### 3.1.2 Project Risk Management

Risks can be described as chances that something that could impact outcomes of the business will occur, while risk management can be defined as “culture, processes, and structures that are directed toward realizing potential opportunities while managing adverse events” (Australian Standard Risk management – Standards Australia 2004, cited in Zou et al., 2010, p. 854). Risk management is crucial part of projects nowadays and is gaining more importance. Managing risks and opportunities within projects is integral part of good management (Cooper et al., 2005, p. 2). Business and project objectives can be achieved better by applying risk management, with benefits not only in detecting possible bad results but also leveraging on the positive ones (Monetti et al., 2006, p. 1). Identifying the risks related to the activities of the business and/or projects, and later managing them, is fundamental in the decision-making processes of the company, as this will affect the expected outcomes. Moreover, it is closely related to good decisions being made, and those can be related further again to risks as every decision implies possible risks (Pritchard, 2001, cited in Monetti et al., 2006, p. 1).

The importance of risk management can be portrayed also from different perspectives; for example, from the stakeholder’s point of view of the specific business or project.
According to Cooper et al. (2005, p. 1), risk management of projects is important for several actors, such as managers, project staff, end users, suppliers and contractors, financiers, and insurers due to their role in projects. Baloi and Price (2003, p. 264) shed a light on two perspectives on how project risks could be analysed: one from the viewpoint of the client, who is the one having the highest power in decision making; the other from the contractor’s viewpoint as it is the entity who could increase the costs to hedge risks (Baloi & Price, 2003, p. 264). It’s important to notice that, even though the client has the highest power in decision making, it is the responsibility of the project management team (contractor), who has the capability of identifying and assessing the risks, to take the first step in the decision making in which risks to hedge or which to tackle. However, the client takes the final decision of how to proceed.

According to Project Management Body of Knowledge (PMBOK), risk management process consists of certain elements during the project management. These processes are: plan risk management, where the risk management plan and risk management strategy should be formulated; identify risks, where the risks are categorized, causes are identified and the first risk register is built; perform qualitative risk analysis, where the probability of occurrence and the severity of each risk is assessed qualitatively and the risk register is updated; perform quantitative risk analysis, where the occurrence and severity before assessed is given a quantitative value and again the register is updated; plan risk responses, where a risk response plan is made according to the risk register assessment; and monitor and control risks, where corrective and preventive actions are recommended.

These processes are very general as it is just a guide of how risks could be tackled within projects; however, they allow to elaborate on a more specific industry and give a direction of how project risk management could be carried out.

In Figure 2, the steps of the risk management process are enumerated and described. These steps should be part of the project management process, and carried out through
all the phases of the projects. Nevertheless, many of these steps are disregarded or not given the importance they require.

3.1.3 Project Risk Management Within the Project Life Cycle

3.1.3.1 Project Life Cycle and Project Extended Life Cycle

Projects are seen as a finite endeavour which end with the delivery of its final result or product to the owner, investor, marketer or user in accordance with the project contract or charter (Archibald et al., 2012, p. 2). From this view, the project life cycle ends when the project close out phase is complete. Later on, at the moment that the product begins to be used, sold or placed in operation producing benefits a product life cycle can be described. There can be an overlap between the standard project close out and the operation of the product extending this way the project life cycle (Archibald et al., 2012, p. 3).

![Project Life Cycle Vs Extended Project Life Cycle](image)

Archibald et al. (2012, p. 24) emphasize that by acknowledging the phases after the close out of the project, the project manager can assess how successful the project was, and therefore, gain knowledge for future projects and how to enhance their results.

3.1.3.2 Project Risk Management Loop of Control

According to Elkjaer and Felding (1999, p. 17), it is suggested to perform a Project Risk Management (PRM) Loop of Control at the end of each project phase or when required by major change of circumstances. The beginning of a new phase of the project, for example, site mobilisation, is a new round of risk identification, assessment and so on as described in the PRM Loop of Control.

The PRM Loop of Control is a comprehensive model consisting of guidelines described within the project risk management process (Elkjaer, 1998, cited in Elkjaer & Felding, 1999, p. 17). The PRM Loop of Control illustrates a dynamic and continuous process in which risks are continuously reassessed until they are prevented, reduced or accepted.
The PRM Loop of Control can be divided into four different phases: identification, assessment, response, and monitoring.

![PRM Loop of Control Diagram](image)

**Figure 4. Project Risk Management (PRM) Loop of Control (Elkjaer & Felding, 1999, p. 16).**

The identification phase is the most critical to a successful risk management approach; risks that are not detected cannot be managed (Chapman, 1997, p. 276; Elkjaer & Felding, 1999, p. 17). For the next phase, risks can be quantified through an assessment of probability and impact (Caron, 2013). “The standard perception of quantification is that probability multiplies impact result in the risk level” (Wideman, 1992, cited in Elkjaer & Felding, p. 18). The risk level can be measured in quantified or qualified units, meaning that either percentages or monetary units can be used. Further a response is needed; the purpose of the response phase is choosing a risk strategy, which can be acceptance, reduction, elimination or transfer (Caron, 2013; Godfrey, 1996, Isaac, 1995 Murray, 1998, Wideman, 1992, Turner, 1993, cited in Elkjaer & Felding, p. 18).

The last phase of the PRM Loop of Control is monitoring which encompasses documentation and reassessment of the risks in order to make sure that the right action has been taken to prevent these risks. Monitoring phase is aimed to ensure that risk register with potential risks is updated in all times and the responsibility is defined (Elkjaer & Felding, p. 19).

### 3.1.4 Risk Management Techniques

Construction companies in different countries use different kind of techniques in risk management to tackle the risks described in the previous chapter, as not every approach can be appropriate for every situation. Several techniques used in risk management process can be identified, such techniques are: brainstorming, checklist, sensitivity analysis and risk register; thereafter, these techniques can be used in two different situations to tackle risks: preventive and remedial actions (Iqbal et al., 2015, p. 70-72). This last will depend if the risk is known or unknown, as described in the previous chapter. All the techniques can be enclosed into two different approaches: quantitative and qualitative.
3.1.4.1 Qualitative Risk Management Approach

Qualitative risk management approach deals with risk’s probability of occurrence and its impact on the project objectives (PMBOK, 2008, p. 289). Assessing the major risks and conducting the risk register is usually a more rapid and less costly plan for risk response as an initial step. The process of qualitative risk management consists of initial inputs such as risk register, risk management plan, project scope statement and organizational process assets. For such inputs, the tools and techniques commonly applied in qualitative risk management are: risk probability and impact assessment, probability and impact matrix, risk data quality assessment, risk categorization, risk urgency assessment, and expert judgment. After applying all the tools of the qualitative risk management approach, the output is an Updated Risk Register (PMBOK, 2008, p. 289), which can be used further on in a quantitative approach.

3.1.4.2 Quantitative Risk Management Approach

Quantitative risk management deals with numerical assessment of risks of the project. This approach allows to gather data and work on major risks in a more complex way. Normally quantitative approach comes after the qualitative approach as it already includes only the most important risks. The inputs of the quantitative risk management are: risk register, risk management plan, cost management plan, schedule management plan, organizational process assets. The tools and techniques that can be applied in quantitative analysis suggested by PMBOK (2008) are: data gathering and representation techniques, quantitative risk analysis and modelling techniques, expert judgment.

As described before, one approach is the complement of the other. For an efficient risk management within a project, a qualitative, and later, a quantitative approach should be considered and used as a complete model. This model is general for project management; however, different industries and projects can apply different techniques.

3.1.5 Risk Management in Construction Projects

The construction sector is an active and dynamic industry, but one that contains many hazards and risks (Eid, 2004, p. 22). Risk management is very essential in construction projects, as they often fail to meet deadlines or they overrun costs (Iqbal et al., 2015, p. 67). According to Serpell et al. (2015, p. 202) there is still a lot to achieve within the area of risk management in construction projects due to the increasing importance of the performance and success of construction projects where consequences of risks are relevant. It is not only essential to include risk management as a part of the project in the construction industry, but also do it in an efficient and effective way (Zou et al., 2010, p. 855).

There are several reasons why risk management should be included within construction organizations: each project is unique and, thus, implies risks; it involves different actors, different methods, temporary organizations; there is an inadequate use of efforts and resources; risks alter by time due to “changes in legislation, effects of related authorities, adoption of non-standard building contracts, and uncertain site conditions” (Zou et al., 2010, p. 854). As stated by Sharma and Swain (2011, p. 109), managing construction project risks, determining the types of project risks and classifying them are fundamental steps; as they could enable the assessment process to be carried out,
later determining the level of each risk and the consequent severity effects in a project’s activities. The identification and classification of risks within construction projects is essential, but the steps following are just as important. The assessment of risks, definition of actions and controls, and a constant communication complement the risk management process.

Risk management in construction projects is usually applied as from previous experience and judgment of the experts rather than using risk analysis techniques due to the time-consuming process and knowledge insufficiency of the tools (Akintoye & MacLeod, 1997, p. 31). However, the application of risk management techniques of easy use and that deliver expected results in terms of identifying, analysing and mitigating risks are essential; even more, when dealing with sustainable projects, as those involve new technologies and practices that are still being developed.

### 3.2 Sustainability

Several authors have pointed to the innumerable interpretations of sustainability (Lankoski, 2016, p. 848). Sustainability is commonly defined as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development (WCED), 1987, cited in Bansal & DesJardine, 2014, p. 71), a concept that is accepted in many fields of study that include a sustainable approach. Dyllick and Hockerts (2002, p. 131) define sustainability as “meeting the needs of a firm’s direct and indirect stakeholders” without compromising its ability to meet the needs of future stakeholders. They also argue that sustainability should be integrating economic, social and environmental aspects, in a short and long term (Dyllick & Hockerts, 2002, p. 132). According to Carter and Rogers (2008, p. 364) most of the definitions of sustainability incorporate economic and environmental factors. Shrivastava (1995, p. 955) describes sustainability as “the potential for reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management.

Essentially, sustainability considerations are about transactions and compromises, basically between the social, ecological and economic dimensions in the “short, medium and long term”; providing equal opportunities for development and well-being (Talbot & Venkataraman, 2011, p. 29). “Although ‘sustainable development’ has been a dominant concept in planning and policy making for over 15 years, there is still no consensus over the societal goals that would count as sustainable development as a matter of definition, or would contribute to it in practice” (Connelly, 2007, p. 261).

As explained before, the concept of sustainability is linked to economic, environmental and social dimensions and their interrelations, forming the Triple-Bottom Line (TBL), which should also be integrated into the project management function (Martens and Carvalho, 2016, p. 30). “The triple bottom line suggests that at the intersection of social, environmental, and economic performance, there are activities that organizations can engage in which not only positively affect the natural environment and society, but which also result in long-term economic benefits and competitive advantage for the firm” (Carter & Rogers, 2008, p. 365). This is the main reason companies are driven to the implementation of sustainable projects and sustainable activities. The application of sustainability considerations is relevant for project efficiency as well as project
effectiveness; “executing the best project in the best possible way” (Økland, 2015, p. 104). Therefore, this implies incorporating increasingly sustainable solutions, tools and materials while yet being able to prioritize the goals and objectives of the firms (Økland, 2015, p. 104).

For this thesis purpose sustainability is defined as the use of solutions, tools and materials in order to reduce long-term risks associated with resource reduction, energy consumption, product liabilities, and pollution and waste management, enabling future development.

3.2.1 Sustainable Construction Projects

The term “sustainable construction” was first proposed to describe the responsibility of the construction industry in achieving sustainability (Hill and Bowen, 1997, p. 224). “With the increasing necessity for resource efficiency and climate change adaptation, there is a need to implement sustainable principles and practices in construction projects” (Maduka et al., 2016, p. 1). This has driven the construction industry in the development of new technologies, from modern designs to revolutionary materials and new construction practices; that way, new concepts in the built environment have been introduced such as: sustainable construction, green buildings and high-performance buildings.

It is necessary to make some distinctions in concepts commonly used in the built environment regarding sustainability. The terms: high-performance buildings, green buildings, and sustainable construction, are often used interchangeably and because of this, confusion among the terms occurs. Many authors in the sustainable construction area do not distinguish these terms, hence using them as one. Kibert (2013, p. 7) makes this distinction; the term sustainable construction addresses the ecological, social and economic issues of a building in the context of its community (Kibert, 2013, p. 8). In 1994 the Conseil International du Bâtiment (CIB), an international construction research networking organization, defined sustainable construction as “creating and operating a healthy built environment based on resource efficiency and ecological design”.

The term green buildings refer to the quality and characteristics of the actual structure created using the principles and methodologies of sustainable construction. Green buildings can be defined as “healthy facilities designed and built in a resource-efficient manner, using ecologically based principles” (Kibert, 2013, p. 8).

A high-performance commercial building “uses whole-building design to achieve energy, economic, and environmental performance that is substantially better than standard practice” (Kibert, 2013, p. 8). This requires full collaboration between design specialities from the project’s inception, thus, creating an integrated design. Whole-building, or integrated design considers site, energy, materials, indoor air quality, acoustics, and natural resources, as well as their interrelation with one another (Kibert, 2013, p. 8).
Figure 5. Model for sustainable construction projects.

The model in Figure 4 shows how the concepts above described relate to the projects. As it can be seen, green buildings are strictly related to the construction process, and how the sustainability goals can be addressed throughout such process. On the other hand, high-performance buildings are a final product, that throughout their life cycle, tackles the sustainability goals not only during the construction process but also after the close-out of the project when it starts to operate. Finally, sustainable construction encloses both green buildings and high-performance buildings in company’s objectives level towards being sustainable.

Sustainable construction provides a response to issues of environmental impact and resource consumption. The Organisation for Economic Co-operation and Development (OECD) estimates that buildings in developed countries account for more than forty percent of energy consumption over their lifetime including materials, construction, operations, maintenance and decommissioning. This provides an opportunity to the built environment to make major contributions for a more sustainable future.

Sustainable construction targets to fulfil present day needs for infrastructure without damaging more the environment, as construction has been identified as particularly important because of the significant environmental and social impacts that the built environment has (Petri, 2014, cited in Maduka et al., 2016, 3). Sustainable construction ideally incorporates elements of economic efficiency, environmental performance and social responsibility, all this combined in a design of architectural quality and efficiency.

Addressing green buildings and high-performance buildings nowadays is not a simple task. Technology, in form of materials, systems, construction techniques and design, is often developed to fulfil the objectives of sustainable construction; representing major challenges for this trend, which however need to be addressed.

Nowadays, several standards for green building already exist on the market, but as standards, those are not legally binding, therefore, are being taken as rather guidelines of what can be done. The most recognized standards, and the ones most of the industry uses, include: The Leadership in Energy and Environmental Design (LEED) from the U.S. Green Building Council; the Building Research Establishment Environmental Method (BREEAM) first published in the UK; and more specifically in Sweden with
the Sweden Green Building Council, being a partner of the U.S. Green Building Council.

### 3.2.1.1 The Challenges in Sustainable Construction

The construction industry, that includes areas such as design, construction, operations, renovation, and disposal of buildings, should change considerably to meet the future challenges of building. Over time, professionals in the built environment, backed up by experience, research, and the development of better systems and products, will be able to design buildings that are more resource-efficient than today’s green buildings and that will have far lower impacts in their construction and operations (Kibert, 2013, p. 490). The most important characteristics of the ideal green building, in terms of high performance, are based on making improvements in areas such as: energy, water, materials, natural systems interface, design, human health; this with technologies that are already available or developing new ones.

According to Kilbert (2013, p. 491), changes in the following areas must take place:

- **Technology:** Technologies that minimize resource consumption and the environmental impact of the built environment need to be developed.
- **Policy:** As a general matter of policy, building need to be created based on life-cycle costs as well as first costs.
- **Incentives:** Government needs to develop financial incentives for high-performance construction, such as priority review by building departments, accelerated approval for projects of this type, and reduction in impact fees and/or property taxes for a specific period.
- **Education:** All the professionals in the industry need to be educated and trained in the need, process and approaches for creating high-performance green buildings – owners, architects, engineers, landscape architects, interior designers, construction managers, subcontractors, materials and product manufacturers and suppliers, insurance and bonding companies, real estate agents, building commissioning consultants and other professionals engaged in the process.
- **Performance-based design fees:** Contracts for design and construction services need to be revised to offer incentives to the building team to meet and exceed project goals with respect to resource consumption and environmental impacts.
- **Construction Process:** The physical process of construction needs to be changed to ensure that the activities involved in erecting the building have the lowest possible impact.

It is important to understand that meanwhile all these challenges, and therefore changes in the way current construction is being carried out are not addressed, implementing green construction will represent an increment in the construction costs, as technologies are being developed for specific projects as projects are designed and developed.

### 3.2.1.2 Green Building Economics

Economic factors are normally the highest priority for owners when new standards or technologies are introduced into the construction industry (Gan et al. 2015, p. 62). High-performance buildings involve an investment cost that varies from less than two percent
to more than ten percent when compared to the costs of traditional construction (Tollin, 2011, p. 202).

The additional construction costs often associated with high-performance buildings are a consequence of several factors. The practice of sustainable construction is concerned with the application of advanced technologies, which demands resources such as humans and materials (Hill & Bowen, 1997, cited in Gan et al. 2015, p. 63). The systems often incorporated in high-performance buildings that are not typically present in conventional buildings and green building certification (fees, compilation of information, preparation of documents, cost of consultants) can add significantly to the costs of a project (Kibert 2013, p. 465). Added to that, green building products cost more than their equivalents, often because they are new to the market, therefore the demand is still not high (Hwang and Ng 2013, p. 276).

Understanding the economic effects of this trend and including them in the decision-making process is of crucial importance. The classical approach used in assessing high-performance building economics is life-cycle costing (LCC) (Lam et al. 2010, p. 654), which includes a consideration of both construction costs and operation costs (Kibert, 2013, p. 466). These two major cost factors are combined in a cost model for LCC that considers the time value of money, the cost of borrowed money, inflation, and other financial factors.

One of the schools of thought in respect of the economics in high-performance building maintains that the construction cost of these buildings should be the same as or lower than that of conventional buildings (Kibert, 2013, p. 466). The basis of this argument takes place in the fact that through an integrated design the costs of high-performance building construction can be kept in line with those of conventional buildings. The ING Bank building, south of Amsterdam in the Netherlands, completed in 1987, is an example of a high-performance building. This building costs about $1500 per square meter, including the land, the building and its furnishings. “At that time, this cost was comparable to or less than that of other bank buildings in the Netherlands” (Kibert, 2013, p. 479). Added to that, it was built with existing technology, often used in traditional building. If all high-performance buildings could be designed and constructed at the same high level of architectural and engineering quality and at the same or lower cost as conventional buildings, the case for these advanced buildings would be made.

### 3.2.1.3 Green Building Obstacles

As stated before, green building materials often cost substantially more than the materials they replace. Added to this, the lack of skilled and qualified workers is one of most significant barriers to the adoption of related technologies and methods, which at the same time, such technologies and methods may increase construction time (Gan et al., 2015, p. 63). The additional cost, and those associated with green building compliance and certification, often require owners to add a separate line item to the project budget (Kibert, 2013, p. 479).

Despite the success of the green building movement in general, plenty of challenges arise when implementing sustainability principles within the construction industry (Kibert, 2013, p. 480). Uncertainty and risk associated with new green technology is
common (Lam et al., 2010, p. 655). The fear for higher investment costs of sustainable construction compared to traditional building and the risks of unforeseen costs represents possibly the most commonly addressed obstacle for sustainable construction.

Many studies have verified that green technologies pose certain obstacles for developers, clients and contractors (Hwang & Ng, 2013, p. 276). Industry professionals, in both the design and construction disciplines are generally slow to change and tend to be risk-averse, as the industry is a conservative one (Kibert, 2013, p. 480; Lam et al., 2010, p. 655).

While the benefits of green construction exceed the risks, there are green building exposures if the design, construction, or operations of the green building are not as expected. Risk associated with reliability and effectiveness of a new product prevents many professionals from specifying green or sustainable building materials (Lam et al., 2010, p. 655). “Building codes are inherently difficult to change, and fears of liability and litigation over the performance of new products and systems pose great challenges” (Kibert, 2013, p. 490, Nutter, 2012, p. 2).

To understand the importance of risks within green buildings, the following chapters shed a light on risk management and concepts within risk management in construction industry to also show the relevance and interconnection between these two knowledge areas.

### 3.3 Sustainability Risk Management

Sustainability risk management is concerned with environmental and social responsibility risks (Anderson and Anderson, 2009, p. 25). It refers to the embedding of sustainability risks into the risk register and managing them accordingly. Sustainability risks can be broken down into three broad categories: they include existing and emerging environmental, social and governance risks. Also, referred to as non-traditional risks, sustainability risks arise when corporate behaviour, or the actions of others in a corporation’s operating environment (e.g. suppliers, media, government), create vulnerabilities that may result in financial, operational or reputational losses in value. Sustainability risk management is an emerging topic and little research has been made on it. Authors like Anderson and Anderson (2009) or consulting companies as AsherLeaf Consulting Inc. (2011) draw a picture showing that sustainable risks should be managed as common risks within the risk register. They set the difference between usual risks and sustainable risks in the identification phase, as sustainable risks are related to sustainable practices within a firm’s activities.

To conclude, sustainability risk management is crucial part of companies dealing with construction, however, a lot of them misuse the term sustainability or there is not always common understanding of what it means; that is why the next chapter tries to explain the terminology within construction industry.

### 3.4 Risks in Green Construction

Many of the risks related to green construction are very similar to issues traditionally associated with construction projects such as uncoordinated drawings, construction delays, and noncompliant construction, just to name a few. But other risks can be
specifically related to sustainable design and construction practices primarily because of the use of green materials, systems, and procedures. According to Nutter (2016, p. 2), the top 6 risks of green construction are explained in the following paragraphs.

**Higher than anticipated operating expenses**—excessive energy use, water use, and maintenance. It is usually related long-term savings with a sustainable and integrated design; as a common belief that the design will enable less consumption, therefore, savings will be present in the operations. Unfortunately, this is not always the case. Nonetheless, the criteria that must be met to comply with any regulation and/or standard, the risk is that projections of cost savings may not be achieved at the completion of the building or at least not at the expected levels. Or, even if savings are achieved, other unforeseen costs associated with the savings activities might appear (Nutter, 2016, p. 3).

Some authors typify resource consumption as high interest subject, mainly because it commonly represents a significant percentage of a building’s operating costs (Nutter, 2016; Kibert, 2003). It is also one of “the mantras of sustainable design: consume fewer resources” (Nutter, 2016, p. 4). Therefore, the risk associated with unanticipated operating costs does stand as one of the greatest risk in green projects. It is also an issue regarding project liability, and the responsibility falls in the designers, contractors and owners.

**Establishing conflicting standards**—creating unachievable project requirements. New standards are being developed and used at a high rate that it is difficult to expect that they will all be compatible, complementary, and coherent (Nutter, 2016, p. 5). Designs must be able to satisfy the basic code requirements, while also meeting the requirements set by LEED or any other standard, either adopted by a local government or state or demanded by the client. Even with review and consideration during the design process, some requirements are difficult to establish in advance.

In many cases, conflicting standards can be addressed as they emerge. Standards can be aligned with new codes, or orders of precedence among the standards can be established to make corrections automatically when identified. If high conflict between standards or requirements exist at the time a project is being initiated and they are not identified and solved until the construction is initiated, the potential for delays, significant cost overruns, and even accompanying litigation increases.

**Construction schedule and cost impacts associated with delivering a sustainable building.** Delay is one of the most common issue in construction and often represents the largest cost overrun. Delay is not a new issue in green building; however, the impact of delay on green projects may lead to unexpected results. Delay can also arise from a lack of availability of materials (Kibert, 2013, p. 355). Being dependant on the supply location and provider, increases the risk of delay.

Delay can also come from a lack of fitting planning of the steps required to complete a green project. One of the most commonly phases when this happens is in the commissioning of the building, after project completion, where systems like heating, ventilating, air-conditioning, plumbing and electrical among others should be tested as a prerequisite of functionality, especially for sustainable designs, as complying with the
standards is paramount for achieving high-performance. Activities like this can be complicated and time consuming (Kibert, 2013, p. 355; Nutter, 2016, p. 6).

“As sustainable design processes and products become more common, designers, contractors, and owners will likely encounter fewer delays or supply issues that are green specific” (Nutter, 2016, p. 6). In the meantime, as described by Nutter (2016) and Kibert (2013), as construction specifications are developed to adapt more supply options and as professionals in the built environment gain knowledge and experience in the complexities of compliance with green standards, issues and disputes will continue to arise.

**Failure to meet green code or green certification requirements** during the design phase, due to client design changes, or during construction. Professionals in the built environment have an obligation to provide services that satisfy the requirements of approved codes as well as the additional requirements of their contracts. When those obligations are not met, problems arise. Green design and construction is no different except the standards are newer, and in many cases more complicated, therefore the expectations are higher (Nutter, 2016, p. 7). Careful attention to requirement, both by code and standard as for client requirements, have to be evaluated if are achievable or not.

**Employing materials and equipment with reduced life cycles or immediate aesthetic or performance failures.** Not only green building, but traditional one as well, require lasting and tested materials and equipment for their buildings, in other words, the most sustainable and with the highest quality (Nutter, 2016, p. 7). New products and technologies are often launched, marketed as “green” and “sustainable”. Some of these products are new to the market with only laboratory testing to confirm basic performance and code compliance, and without extensive field testing (Kibert, 2013, p. 479; Nutter, 2016. p. 7).

As explained by Kibert (2013, p. 370) the product and equipment quality and performance is also affected by their maintenance. “Depending on composition and complexity, green materials may require a more frequently or more difficult maintenance than conventional materials and may also require the use of different products to preserve and protect less resilient finishes” (Nutter, 2016, p. 7).

While product and equipment failure is not strictly related to green building, as it has been a problem in the construction industry, it is rising as new products are rapidly developed, launched, and implemented (Nutter, 2016, p. 7; Kibert, 2013, p. 371). Depending on the affected areas, phase of the construction process, the nature of the product or equipment, and the need of repair or replacement, green material and equipment failures could result in high cost impacts.

**Damage to environmental and professional reputation.** The consideration of sustainability in building design and construction is often a priority that goes beyond an investment based decision. “If a green building falls short of the immediate expected goals of certification and energy savings, or the longer-term performance goals, it could affect the reputation of the company or person behind its commissioning. It could also affect the professional reputation of the project’s designers and contractors (Nutter,
2016, p. 8). Because of this, many professionals in the built environment are still, risk averse regarding green building.

There is still a lack of experience and limited knowledge in green construction projects, adding to that, new materials and technologies being developed for specific projects. All this lead to the risks listed above, and in a project, it transfers to the final construction costs associated to it. There is no specific Risk Management to tackle these risks, therefore, construction companies are forced to use their traditional models. There is a need in the literature in terms of risk identification, as interesting to point out that most of this “green” risk identification has been made by authors in the legal area, as many litigations have been made concerning failures in green construction, that are tied up with contracts, therefore, legal binding.

There is also a need to know how the traditional models can be modified to cope with the current demands due to sustainable construction. To draw a picture of this problem a proposed model is developed regarding the project phases and the risks associated with them and can be seen below; added to that how green building affects such model. This model is showed to emphasize the need to see green buildings not only as a project cycle, but also to take into consideration what happens next, as mayor problems can arise after the project close-out, but companies can still be bound by contract specifications.

Some of the risks are expected to appear after the commissioning of the projects, where the construction firms are already not present in the site; current Risk Management Models do not tackle this phase of the project because of this. In this phase the projects normally are in control of the users, but as part of the legal liability, the construction firms should mobilize staff and solve such problems. This is transferred in unexpected expenses increasing the construction costs.

The model in Figure 5 below outlines the risk management process described in the PMBOK (2008) and describes the relationship with what the current theory of what has been done and what should be done, according to the research gap, regarding the project life cycle. Also, it shows the relationship between the risks due to sustainable construction practices and the project phases, where those risks are more probable to occur, and therefore, current theory may be able to identify. It is important to point out that some authors (Iqbal et al., 2015; Tsenrng et al., 2009; Kibert, 2013) have found that the risk management process outlined in the model is not carried out because of a lack of time and knowledge, increasing the probability of risk occurrence, as those risks are not properly identified. That is why differences between the state of current theory and current practice should be stressed out, as what is known is not always applied by practitioners in the industry.
Figure 6. Framework of Relationship between Risk Management, Sustainable Construction and Project Life Cycle.
4 PRACTICAL METHODOLOGY

This chapter outlines the research design for the study which helps to reach the aim of the thesis and answer the research question. This chapter consists of description of the sample chosen, access of it and how the respondents were chosen. Further the interview is described and the procedure of how the data for the empirical part was gathered. In the end of the chapter also ethical and societal considerations are explained.

4.1 Data Collection

4.1.1 Data Collection Techniques and Procedures

As there are several research techniques, there are several data collection methods as well (Sreejesh et al., 2014, p. 20). For this thesis, primary and secondary data is needed for the multi-case study analysis.

For the primary data, a research interview was selected as the best data collection technique. “The research interview is a purposeful conversation between two or more people, requiring the interviewer to establish rapport and ask concise and unambiguous questions, to which the interviewee is willing to respond, and to listen attentively” (Saunders et al., 2016, p. 390). According to Eriksson and Kovalainen (2015, p. 93) three types of interviews can be conducted within qualitative studies, such as structured and standardized, guided and semi-structured, and unstructured, informal, open and narrative interviews. Semi-structured interviews allow the pre-designed outline of the topic mixed with varied questions during the interview to explore the research questions of ‘what’ and ‘how’ better (Eriksson & Kovalainen, 2015, p. 94). This type of interview is chosen according to the fact that we want to understand and construct a new model from the respondents’ viewpoint combined with the theory underlying it.

The semi-structured interview enables exploratory research category which we have chosen. According to Saunders et al. (2009, p. 321) in exploratory research that uses semi-structured interviews can have different sections that discover different issues. The interview consists of two major sections that this research is trying to cover, such as sustainability and risk management within construction industry. As the aim is to encourage the interviewee to speak freely and point out the most crucial parts according to him/her then the interview questions are designed open-ended so that the respondent could answer freely and we could derive more questions from what has been said. According to Patton (2002, p. 350), several types of questions can be asked in semi-structured interviews, such as “experience and behaviour, values and opinion, feeling, knowledge, sensory and background questions”. These guidelines are used not to miss the main ideas and to lead to more than yes or no questions. As this thesis is built on abductive approach, interview was conducted relying on the theory available. Moreover, trying to find out the phenomena that in our opinion is not yet fully researched, however, being taken into consideration in practical world.

Secondary data is mainly built out of data recorded for some other purposes, and include both raw data and published summaries, which can be analysed in order to provide additional or different information, interpretations or conclusions (Bulmer et al., 2009; cited in Saunders et al., 2016, p. 316). Saunders et al. (2016, p. 318) describes
three main types of secondary data: document based, survey based and multiple source based. Document secondary data is increasingly available online, and can include minutes, reports, diaries, transcripts of speeches, administrative and public records. Survey-based secondary data refers to existing data that was collected in a survey strategy with a different objective, and mainly is built out of raw data, data that has not been yet analysed (Saunders et al., 2016, p. 316). Multiple-source secondary data can be compiled from a combination of document and survey-based secondary data; this compilation built to form a new set of data to be analysed (Saunders et al., 2016, p. 325).

This thesis concentrates in the collection of document based secondary data, as public sustainability records and documents will be compiled in order to have a better understanding of how the companies, in which the study cases are made of, operate in terms of sustainability and how are their actual results. This combined with the primary data will provide a holistic view of the companies’ processes in terms of the purpose of this thesis.

4.1.2 Sampling

Following the research question of this study the population target is clear. Therefore, Swedish companies operating in built environment were targeted for our data collection, moreover, managers regarding sustainability and risk management were approached in order to have a clearer response of what we are trying to achieve in this research. As well as independent consultant was invited to add another angle to the findings and view discussed in the thesis.

For all research questions where it would be impracticable to collect data from the entire population, the selection of a sample is needed. Moreover, for many research questions and objectives, it will be impossible either to collect or to analyse all the data available due to restrictions of time, money and more important, access. In some cases, one might be able to obtain permission or gain access to collect data from only two or three organisations (Saunders et al., 2009, p. 212). Therefore, theory states that there are two types of samples that can be used, and the use of any will depend on the type of study and the research strategy.

Samples are generally categorized as either probability samples or non-probability samples. The difference between the two is that probability samples use random processes rather than human judgments to select the study subjects. Non-probability samples “allow human judgments, either purposefully or unintentionally”, to influence which subjects are selected for a study (Henry, 2009, p. 79). For non-probability samples, the probability that each subject has of being selected from the total population is not known and “it is impossible to answer research questions or to address objectives that require to make statistical inferences about the characteristics of the population” (Saunders et al. 2009, p. 213). Non-probability sampling provides a range of alternative techniques to select samples based on the author's subjective judgement. As argued by Henry (2009, p. 79), for some business and management research projects, the research question, objectives and choice of research strategy may dictate non-probability sampling.
Due to the nature of this study, the qualitative approach that has been taken, and the uncertainty of how large the sample can be, added to the stated in the limitations before that no statistical generalizations will be made, a non-probability sample is used. Non-probability samples are used to provide information about specific cases or members of the population enclosed in the study, that are interesting or important for it. According to Henry (2009, p. 79), non-probability samples are used to guide data collection to get specific experiences of the selected subjects of the study population, to explore a perceived social problem or issue, or to develop theories that are grounded in actual experiences of subjects that are part of that population. It is important to emphasize that it is still possible to generalise from non-probability samples but not on statistical grounds.

For this study a self-selection sampling is used. This type of sampling occurs when any subject in the population expresses their desire to take part in the research. Therefore, to publicise the requirement of cases is needed, either by advertising through media or by asking them to take part and the data is collected from those who respond (Saunders et al., 2009, p. 241). For this research, managers from different companies in Sweden operating in built environment were contacted via e-mail and as expected, a few responded.

To answer the research question and to meet the objectives set, an in-depth study that focuses on a multiple-case study in which the research question can be explored and theoretical insights gained, may be needed (Saunders et al., 2009, p. 233). Hence, a snowball approach was also taken (Henry, 2009, p. 82; Goodman, 1961, p. 148). The managers contacted first, identify additional members of their companies to be included in the sample, and that way build an in-depth case study to gain insight of the company and to explore the research question within an experienced firm. With each additional member interviewed a stage of data saturation can be reached (Guest et al., 2006, p. 61) that can satisfy the research within a case study. In order to have unbiased view of the companies, also consultant’s view is added.

As many authors state, for a non-probability sample, with which is possible to answer questions such as ‘what’ and ‘how’ that characterize a qualitative approach, techniques as surveys and interviews can be used (Henry, 2009, p. 80; Saunders et al., 2009, p. 213). For this study, a semi-structured interview will be made to the subjects of the sample. It is important to stress in the time limitations of this thesis development; because of this the approach of the combination of a self-selection sampling and a snowball sampling was taken.

4.1.3 Respondents Selection

The respondents’ selection is done in a rather careful manner; the respondent had to fulfil a number of criteria in order to obtain data useful for the thesis. The criteria for the companies are as follows:

- Criterion 1 - The company/consultant should operate in a built environment;
- Criterion 2 - The company/consultant should be Swedish and/or operate in Sweden;
- Criterion 3 - The company should have a record of sustainable projects.
This selection is essential to assure that no parameter of our interest would be excluded (Silverman, 2011, p. 388) and to be able to answer to the research question proposed in the beginning of the thesis by conducting valid multiple-case study and aligning it with the theoretical framework (Yin, 2003, p. 47).

Moreover, careful attention was set in the selection of the interviewee, which was chosen according to certain criteria similarly to companies’ selection. The criteria were as follows: belong to a relevant position within the company, this could be a Project Manager, Sustainability Manager and/or Green Development Manager. This way we could be sure that the information gathered will be useful to the thesis.

The general search of the sample is done through search engines that could provide contact information about Swedish companies in the construction industry, later narrowing down to companies that offer sustainable construction projects.

A summary of the interviewees is presented below, with their position in their company. It is necessary to highlight the fact that the interviewees were top level managers inside their companies, which lead us to believe in the accuracy of the information gathered. We invited separately also consultant in sustainable construction in order to gain insights on general trends without bias of working in company, in this way we could support the findings within the companies with the viewpoint of individual consultant and academic in sustainable construction management.

<table>
<thead>
<tr>
<th>Table 1. Interviewees.</th>
<th>Position</th>
<th>Date</th>
<th>Duration</th>
<th>Via</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skanska AB</td>
<td>Green Development Manager</td>
<td>22/November/2016</td>
<td>0:50:00</td>
<td>Telephone</td>
</tr>
<tr>
<td>Skanska AB</td>
<td>Vice President Risk Management</td>
<td>06/December/2016</td>
<td>0:45:00</td>
<td>Skype</td>
</tr>
<tr>
<td>Sweco AB</td>
<td>Risk Management Group Manager</td>
<td>09/December/2016</td>
<td>0:45:00</td>
<td>Skype</td>
</tr>
<tr>
<td>Consultant</td>
<td>Sustainability Construction</td>
<td>13/December/2016</td>
<td>0:40:00</td>
<td>Telephone</td>
</tr>
</tbody>
</table>

4.1.4 Interview Guide and Procedure

To build the interview guide, the topics developed in the theoretical framework were used. The interview guide was set for the interviewee to be able to see which were the interview’s objectives and what we were aiming at, also to control the order of the topics, however, natural flow from the answers of the respondent was developed. The questions in the interview guide were set to gain knowledge of specific aspects of the topics in the theoretical framework. Such topics are:

- Risk Management - as described above, business and project objectives can be achieved better by applying risk management, with benefits not only in detecting possible bad results but also leveraging on the positive ones (Monetti et al.,
We aim, with this topic, to understand how the risk management processes were changed or modified in order to adjust to sustainable projects; or even to know if those processes maintain their previous framework. We seek to gain knowledge in any process change in risk management, from risk identifications to risk management techniques.

- **Sustainability and Sustainable Construction Projects** - The application of sustainability considerations is relevant for project efficiency as well as project effectiveness; executing the best project in the best possible way. Doing so implies incorporating increasingly sustainable solutions, tools and materials from areas such as sustainable construction, while yet being able to prioritize with regards to the “big picture” which is the objective of any company: be competitive and profitable (Økland, 2015). We seek to understand what does sustainable projects mean to the company, how do they tackle sustainability. Also, we aim to gain knowledge about how and why the companies being interviewed do sustainable projects, what drove them into the execution of such projects, and if they have been benefited from this.

- **Risks in Sustainable Construction** - Many of the risks related to green construction are very similar to issues traditionally associated with construction projects—uncoordinated drawings, construction delays, and noncompliant construction, just to name a few. But other risks can be specifically related to sustainable design and construction practices primarily because of the use of green materials, systems, and procedures (Nutter, 2016, p. 3). With this we aim to understand how these companies deal with the new “green technologies” and how they implement them. Also, we seek to understand what are the main obstacles and risks they find in sustainable construction.

When the main parameters of the search were identified, a general e-mail was sent to the person we wanted to interview. In order to make sure that any unwanted miscommunication would occur, e-mails were sent in English and also the further communication was held in the same language as all the respondents are highly fluent in English. The e-mail with general information about the research and the purpose of it was sent once the interview was approved, as well as semi-structured interview guide was included according to the person we interviewed (Appendix 1, Appendix 2). The approximate time stated in the e-mail was one hour and prior research on the company or the person we spoke to was made in order to know what could be expected and what new information from the respondents we could gain. In total, only those companies that have special sustainability department were chosen as the respondents of the interview and, thus, considering the information gathered from the interviews, we believe that the sample is enough to draw some conclusions and answer the research questions (Ritchie et al., 2003, p. 83). However, we need to take into account that Skanska gave us deeper insights of their company as we could interview two of their employees while Sweco provided us only one contact for both areas of our interest. We tried to diminish the unbalanced issue by inviting independent consultant/researcher and, thus, have more holistic view.

The personal contact (Saunders et al., 2009, p. 324) that was established during the interview was very significant as it helped to have better insights into the phenomena under discussion, and unlike questionnaire, the interview allowed us to really question the matters of most interest and that we found more relevant for each respondent.
Prior to the interview, both interviewers introduced themselves and the topic of the research, also the approximate time necessary to conduct it which was around 45 to 60 minutes. Interviews were held either by phone call or Skype due to the geographical differences and lack of time to visit the respondents for face-to-face interviews. All the interviews were audio-recorded in order to keep the information accessible at any time and to help the analysis to be conducted without bias, and to have correct quotes that could later be used to support the analysis. Respondents were very open to answer the questions and draft version was promised to them. In order to gain deeper understanding of the topic, if during the interview, we felt that there is a lot more information that we could discover from somebody else within the company, we would ask further contacts for the responsible of our interest. This would lead to better understanding of the case and deeper insight into company’s way of dealing with sustainability and risk management. Directly after the interviews it was decided to transcribe them in order not to miss the main points that were stressed out during the interview, and to have better research analysis as these transcriptions are the ones that contribute to it the most (Merriam, 2009, p. 110). It was felt in some occasions that respondents were trying to search for correct terminology in English and maybe if they would have had a possibility to answer in their mother tongue, it would consist of interesting industry jargon, however, these were minor issues that perhaps allowed them to explain some specific terms in a more detailed way.

4.2 Data Analysis

Qualitative research poses a challenge to the researcher in terms of how to reduce the amount of data gathered from in-depth interviews and written documentation (Adams et al. 2007, p. 155). Data analysis procedure is complex job and involves demanding process when the data is qualitative (Saunders et al., 2009, p. 484). To start the analysis, all data collected should be prepared. Summaries and notes of the interviews may be useful for the further analysis of the information (Adams et al., 2007, p. 156). The interviews conducted with the respondents were audio-recorder and further transcribed, in other words, reproduced into written form with the actual words. In order to not miss the main points discovered through the interview, they were transcribed straight after the interview was conducted. Data collection and analysis is interactive process that was done according to the approach taken within this thesis - abductive approach. From the findings in theoretical framework combined with the findings from the respondents point view, the further questions and data was searched and applied. When some patterns or relationships previously neglected started to emerge, some additional parts were added to the discussion and helped to shape the further direction of the study. Bryman and Bell (2015, p. 581) point out that this can happen during interview process.

Yin (2003, p. 109) describes different ways in which case studies can be analysed, these include: relying on theoretical propositions, rival explanations and developing case descriptions. According to the author, relying on theoretical propositions is the most common strategy used by researchers in case studies, as it relies on the theory that led to the actual case study (Yin, 2003, p. 111). This is the case of this thesis, in which the case studies were constructed from theories presented before.

The data is analysed according to the companies interviewed and theoretical frame of reference is applied within each company separately. This categorization by company allows more in-depth analysis into practical world of the industry and by understanding
the specifics of each company, also the specifics of our findings can be more easily
drawn. It is important to emphasize that the companies are not compared, rather the way
they conduct their risk management processes regarding sustainable projects, as that is
the centre of this thesis. According to Miles and Huberman (1994, p. 25) the present
study’s ‘heart’ is the processes as we are trying to understand and construct the meaning
of particularities of processes related to management of risks within the organizations.

The transcribed data was systematized according to the theoretical framework
developed, by the topics covered in the literature review. The information from the
interviews was categorized according to the same parts in theory, such as risk
management, project risks, green building challenges and risks and sustainability within
the strategy of the company. The analysis was done in the order that our theory suggests
which allowed it to be more coherent and arrive to the necessary conclusions.

Data was categorized according to the following network of relationships:

![Network of Concepts for Categorizing Data]

*Figure 7. Network of the concepts for categorizing data.*

This network allowed to manage the data that we gathered from the interviews easier
and to develop more holistic discussion afterwards including all the necessary
components of the existing theory.

### 4.3 The Credibility of Research Findings

The credibility of the research findings is closely related to the findings and whether
they can be generalized, are they reliable and valid. Generalizability is only possible if
the “case study design has been appropriately informed by theory” (Rowley, 2002, p.
20) and would finally build on the existing theory and add some new findings. We have
used our analytical findings to try to improve the theory already established by using the
largest and most successful organizations within our area of interest. We have tried to
present two largest companies in construction industry in Sweden supported by the
opinion of the consultant firm to make sure that our findings can be generalized and
applied also further in the world of practice in similar environment.
To make sure that our research is qualitatively conducted, also reliability and validity are discussed further. Four tests are usually carried out in order to establish quality of empirical research: conduct validity, internal validity, external validity and reliability (Rowley, 2002, p. 20).

According to Saunders et al. (2012, p. 193), constructing validity could be achieved by using proper operational measures so that subjectivity of data collection would be excluded. Using multiple sources for data collection and relying not only on the one respondent, we tried to apply triangulation within our research as we utilised also the information available on the web pages of both companies. We believe that in this way we could eliminate any possible subjectivity and arrive to more accurate information regarding our findings. We also tried to avoid threats to validity described by Saunders et al. (2009, p. 157) such as history, so there would not be any event that has impacted choices and answers of the respondents, as well as mortality, which deals with participants staying in the study until the end.

Internal validity is the relation between two variables and understanding whether the “findings are really about what they appear to be” (Saunders et al., 2009, p. 157). For this purpose, data analysis was carefully done as we tried to increase the validity of one case by comparing and supporting it with another case as well as opinion of external consultant. Furthermore, external validity is above mentioned generalizability concern that different scholars refer to differently.

Finally, the last of our concerns of credibility of findings is reliability which was reached by choosing data collection techniques and procedures so that they would yield to consistent findings (Saunders et al., 2009, p. 156). We intended to make sure that if the research was to be conducted by others, they would still arrive to the same findings, or even if the same case studies would be analysed once again, they would not change in the general outcomes (Yin, 2003, p. 37). Even though the industry is always growing and new tools within business world are often applied, the general techniques that bring success for the company and the ones we are interested should not change so rapidly. In order to have full transparency of the data analysis, all the interviews were recorded and transcribed, also the interview guide has been attached to this thesis in appendix, and all the materials are saved for this cause.

Apart from credibility concerns of the thesis that we tried to cover such as validity, reliability and generalizability, ethical concerns are crucial as well. The next chapter explains all the considerations taken into account when conducting the research.

4.3 Ethical Considerations

Research ethics and truth criteria are considerations that every researcher should take into account when conducting data analysis. This is closely related to individuals or organisations that are used as research subject and/or are affected by the research in some other way (Saunders et al., 2009, p. 184). Research ethics are concerned with all the phases of thesis paper and that it would be conducted in a moral and responsible way. According to Hammersley & Traianou (2012, p. 7), integrity, transparency and quality are the main concerns that should be ensured when conducting research in an ethical manner. This thesis has been designed, reviewed and undertaken in all the previously mentioned concerns.
Throughout the development of this thesis, starting from choosing the topic and ending with submitting it, we tried to make sure to follow all the ethics of business research. Our choice of topic was not influenced by any outside parties, such as sponsors, supervisors, professors or other students. The organizations that we chose were purely according to their relevance to our study and for the aim of having better findings as well as the individual consultant was chosen according to his in-depth knowledge in the field. The respondents and companies could choose either the information provided would be anonymous or not. We would ask all the participating parts for their consensus of using the data they provided us with and using other materials accessible to public. None of the respondents were interviewed against their will, as we stated that it is of their choice to participate in our research or not and we would not use any kind of power to influence their decision. An email was sent prior to the interview for them to get familiar with the topics and possible questions we are interested in, so that they would have time to prepare for it. We provided all the respondents with the thesis paper before submitting it in order to be sure they are not against the information being presented in the specific way.
5 EMPIRICAL FINDINGS

This chapter comprises the findings from interviews and web pages of companies under discussion. It introduces each company and gives an overview of how they operate by showing the different techniques applied within each company. It starts with findings gathered for Skanska AB as one of the leading companies in the industry in Sweden and further discusses Sweco AB as one of the companies that particularly deals with management of construction projects. First, the overview of the companies is given to set the boundaries and to get insights of the companies under discussion, further processes related to the risk management and sustainability are discussed in the best way to arrive to conclusions how each company applies sustainability and deals with its associated risks. The findings are organized according to the theoretical frame of reference, however, some of the notions turned out to be more crucial in real life than indicated in the theory, so the chapter names are not necessarily exactly as in the theoretical framework.

5.1 Skanska Overview

Founded in 1887, Skanska is one of the world’s leading project development and construction groups, concentrated on selected home markets in Europe and North America. With more than 43,000 employees their operations are concentrated in construction and development of commercial property, residential and public private partnerships (PPP) projects (Skanska, 2016).

Having set their purpose in “building for a better society”, Skanska’s goals are to provide innovative and sustainable solutions to create a sustainable future for its people, customers and communities; all topics related to their core business and expertise. With this, their goals for 2020, aim to set Skanska as the leading company in the industry in terms of shareholder return, value creation, preferred partner, and the most attractive employer (Skanska, 2016).

Skanska has been proactive on environmental management since the mid-1990s; having their first Environmental Report in 1997 and one year later the publication of their Environment Policy. By 2000, all its Business Units worldwide were certified ISO 14001 (Environment Management System standard). This situation remains so today. This company is determined to be the leading green project developer and contractor, being this a focus area in their Profitable Growth strategy (Skanska, 2016).

5.1.1 Risk Management in Skanska

Risk management in Skanska is primarily done locally in Skanska for each project. Support units on Business unit level and for some projects also on group level scrutinize risk as well as opportunities in many aspects before projects are approved by senior management. The main types of risks that Skanska deals with are strategic, financial, operational and regulatory (Skanska.com). Depending on the gravity of the risk, the decision making goes up from the managerial level to board of directors and time for assessment is allocated according to how large or complex the project is (Vice President Risk Management). Company is aware of the importance of the risk management in construction industry and thus claim that it is due to the variety of projects in different
locations and with different designs, suppliers, clients, contracts, etc. This makes it hard to standardize the construction works and they truly believe that skills and experience of their employees are the main drivers towards successful construction. It’s worth emphasizing the fact that the risk management process is done based on experience and expertise in combination with standardized procedures within Skanska.

Within Skanska also exists a Research & Development (R&D) unit. The main task of the R&D unit is to act as an umbrella organization for transferring knowledge of technical solutions and innovations between the various Skanska units and to coordinate technical experts and expertise within the company. Operations in 2015 were based on the current work plan and its focus areas: gathering and transferring knowledge, internal and external networks of experts, technology, trends and innovations, as well as the identification of technical risks. This as support in knowledge and risk management for the project managers.

Vice President Risk Management Skanska AB Staffan Haglind says that the main way how to avoid the most common risks in construction industry such as cost overruns or delays is to put the right people on board and do a proper planning. “The most important thing is actually to involve key competences early on, so we have to make sure that someone with experience in executing and designing green buildings have been involved from very early on” (Mr Haglind). However, as mentioned before, still a lot of challenges are faced during the construction projects and Skanska has developed a specific risk management framework how they deal with these risks and opportunities.

5.1.2 Risk Types

Skanska has indicated four types of risks that they look closely to, such as strategic, financial, operational and regulatory. Strategic risks are closely related to the company’s strategy in general, they are rather long-term and general. This can include business model, acquisitions, strategic allies and partners, as well as Skanska values that are of a great importance for them. Financial risks are related to balance sheet, credit exposure, payment flows, subcontractors, tenants, joint venture partners and clients. All the financial risks are managed by Skanska Financial Services and is a separate department from the department responsible for the construction projects. Operational risks are finally related to the projects themselves and are short-term and specific. In this type of risks both opportunities and negative outcomes in projects are considered. They distinguish between two types of operational risks, such as construction risks and development risks. Risk related to construction are the choice of technology, method and suppliers, as well as climate and weather conditions, while development risks are land acquisition, permits, design, building, leasing, selling, and guarantees for the finished building. Regulatory risks are the ones that are responsible for rules and regulations of business operations and taxes, as well as internal company’s rules (Skanska, 2016).

However, operational risks that this thesis is interested in are usually systematically considered and Skanska is a company that prefers traditional methods of construction that they can rely on and this allows them to be successful in the market. Moreover, if they intend to use new technology or materials, they are usually tested beforehand so no unwanted risks would occur. “We are quite clear on what we can guarantee and under
what circumstances, and what we cannot control or measure, or follow up - we do not guarantee” (Mr Haglind).

5.1.3 Decision Making in Risk Management

Risk management in Skanska is conducted through several steps and procedures depending on the size of the project.

Skanska uses Group-wide procedures for identifying and managing risks and opportunities. For construction and infrastructure projects, the Skanska Tender Approval Procedure (STAP) is used. For residential and commercial development projects, business tailored procedures are used. The Group function, the Skanska Risk Team (SRT), supports SET by examining and analysing tenders, investments and divestments requests subject to top management approval (approximately, 500 projects per year). In addition, projects above a certain size are subject to approval of the Board of Directors. Each business unit conducts risk and opportunities assessments and identifies means for managing those. The figure below shows the structure how the project risk management is carried out (provided by Mr Haglind).

As explained by Mr Haglind, depending on the financial weight of a project or investment, or if it is triggered by certain identified risks, the project/investment will be allocated in a specific level in the decision hierarchy. As can be seen from the figure above, for example, depending on the project’s complexity, projects going for business unit level are scrutinized by BU Risk Team, however, if it has to go to Group level, the project will be scrutinized by Skanska Risk Team (SRT) and Business Unit risk team (country level). The procedure of the scrutiny forum starts with standard template document fulfilling and then is sent further to BU Project Board which is the one who decides either the project should be approved, approved with conditions or not approved. Larger and more complex projects are rather scrutinized by Skanska Risk

![Diagram of project risk management structure in Skanska (Skanska, 2016).](image-url)

Figure 8. Project Risk Management Structure in Skanska (Skanska, 2016).
Team. They have around six days to make video calls, interviews and write up executive summary recommendations for the specific project in order for SET Tender Board to make a decision. SET Tender Board is at the management level and have to make these kinds of decision every second week almost. Projects and investments above certain monetary limits also need approval by Project review committee (PRC), containing all professional Board of Directors of Skanska AB (group level). The standardized process and knowledge Skanska’s employees have allowed them to manage time accordingly to the complexity of the project. They know when more time is needed to be invested and when not.

5.1.4 Green Building in Skanska

Skanska’s first steps into Sustainable Construction started with a major environmental issue occurred in the construction of the Hallandsås Tunnel in 1997. “Actually, it started with a catastrophe, long before. We had an accident in a major site in Sweden” (Åse Togerö, Green Development Manager). Set as one of the worst environmental scandals as in terms of media coverage, Skanska had to deal with the consequences. The root of the problem was a chemical sold to the company advertised as a good product; a leak from the tunnel into groundwater contaminated the water supply, making people and cattle sick. This was a big throw back for the company’s reputation.

With the upcoming appointment of a new CEO, the company was about to change. One of the conditions the new CEO set at that time to take charge was that Skanska should change the way they worked when it came to green and environmental questions. With these changes, a new manager in sustainability was appointed. At that time, he understood that they didn’t have a market for sustainability, but he was confident looking into the future, and he convinced everyone of that. It took around five years to see it happen. “We would have been a boring, traditional company and we would have five people working, trying to fulfill some requirements and doing nothing more” (Åse Togerö).

![Skanska Color Palette™](Skanska.com)

Figure 9. “Skanska Color Palette™” (Skanska.com).
Since 2008, a tough strategy for green was set in motion, summarized in a tool called the “Skanska Color Palette™” (Figure 8). It is the strategic framework and communication tool for Green Business, that has been developed to measure and guide the company’s performance on the process of getting to a point they call Deep Green. This tool enables the classification of the green initiatives that the company does; it is set as a measure on what is done in terms of production and what is delivered to the customers (Skanska’s Sustainability Report, 2015).

### 5.1.5 Project Categorization

As introduced before by Skanska’s Green Development Manager the colour palette describes the level of green of a project.

- **Vanilla**: The construction process and product performance follow law, regulations, codes and standards.
- **Green**: The construction process or product performance is beyond compliance, but not yet at a point where what is constructed and how it's constructed can be considered to have near-zero impact. Green projects must achieve at least 25 percent energy reduction compared with local code, in addition to Skanska's green requirements associated with one or more other green aspect (carbon, materials selection, waste or water).
- **Deep Green**: The construction process and our product performance has a near-zero impact on the environment.

Deep Green is defined by six zeros that relate to Skanska's priority opportunities for reducing the environmental impact of the projects. These are Energy, Carbon, Materials and Water. Projects must realize at least three of the following zeros to achieve Skanska's definition of Deep Green:

- net zero primary energy for buildings and net positive primary energy for civil/infrastructure projects
- near zero carbon in construction
- zero waste
- zero hazardous materials
- zero unsustainable materials
- net zero water for buildings and zero potable water for construction in civil/infrastructure

With more building projects achieving good in-use energy efficiency levels and with more civil projects understanding the link to material efficiency and cost, Skanska has seen an increased interest in the reduction of carbon emissions from operations and construction materials. However, according to Mr Haglind “we usually do not guarantee energy performance before 18 months or we guarantee energy performance at a different level” due to the fact that to optimize how the building operates takes time. Loss of biodiversity is quickly rising as a global concern for which Skanska is defining a strategic response (Skanska’s Sustainability Report, 2015).

Green performance is managed at individual project level and all Business Units have green targets. Examples of green commitments by Skanska's Business Units operating in more mature green markets. The commercial development units in Europe are aiming to only develop Green and Deep Green projects by 2020 - with Deep Green making up
20 percent of their project portfolios. Two of the largest construction units are aiming for a 100 and 80 percent proportion of Green projects in their respective project portfolios by 2020, which includes 15 percent and 5 percent Deep Green projects respectively. More than two-thirds of order bookings in Skanska Sweden and Skanska UK are classified as Green, according to Skanska’s Sustainability Report, 2015.

The measurement of green projects in Skanska is set by their Green Turnover, which describes the percentage of green projects on the overall portfolio of projects that Skanska deals with yearly. “The difference between being a Green project in the color palette compared to a vanilla project makes it possible for us to define a measure of our green turnover” (Åse Togerö). With the green turnover, the development of green projects over time can be seen. With a starting 25% green turnover in 2010, an increase in such projects has been seen with a green turnover between 65% or 70% in 2016 as explained by Mrs Togerö.

5.1.6 Green BIM

The emergence of the Building Information Model (BIM) has transformed the construction industry and is reshaping how projects are delivered. At Skanska, BIM has been implemented during every phase of the project life cycle, from conceptual design through the operational phase. The project life cycle that this company implements is the extended life cycle that considers the phases before and after the common project life cycle, as described by Archibald et al. (2012, p. 6). Using BIM along with sustainable design and construction techniques is referred to as “Green BIM.” Green BIM helps project stakeholders make informed decisions early in the design process and enables a greater impact on the efficiency and performance of a construction project.

![Figure 10. Skansa’s Green BIM (Skanska.com).](image)

Based on their experience, as stated by Skanska, BIM is capable of positively impacting all phases of a project life cycle. BIM significantly enhances the project team's ability to collaborate and use other innovative tools, from prefabrication to virtual models in the field. The design can be easily understood and reviewed to help guarantee its accuracy and completeness. Alternatives can be visualized and evaluated in terms of cost and other project parameters. Sustainability analyses can be performed and different kinds of quantity calculations of spaces and materials can be done. This way they can be certain of complying with codes, regulations and certifications, and fulfil the
requirements of the green project, whatever classification it could have, from Vanilla to Deep Green, set in their “Skanska Color Palette™”.

Nonetheless, as mentioned before, BIM can be used in identifying any possible adverse outcome and advice in which path is better to take. Added to this, Skanska’s Green Concept Plan, helps in the testing and advising in new green technologies that can be applied in Green Construction. For this, they have developed a process that ensures that only low risk, effective and efficient technology will reach their projects, assuring their customers the specified performance of their constructions.

5.1.7 Green Concept Plan

Green concept plan represents a unit within Skanska that is in charge of receiving, analysing, testing and recommending new technology for its use in future projects; it is specially funded for this purpose as Skanska’s top management has identified such process as important to avoid any necessary risk and guarantee the final product that is delivered to their customers. For this, new technology is through several steps, from lab testing to field testing, until it reaches a category of standard construction.

5.2 Sweco Overview

Founded in 1997, Sweco is one of the larger European engineering consultancy companies, active in the fields of construction, architecture, and environmental engineering. With around 14,500 employees, the company is present since 2015 in Sweden, other 12 European countries, Turkey and China. The company is listed at the stock exchange OMX Nordiska Börs in Stockholm and has its historical roots in a number of companies, now merged, such as AB Vattenbyggnadsbyrån (VBB), VIAK AB, FFNS AB and Grontmij; some which were founded in 1889 (Sweco, 2016).

Sweco’s core business is based in the planning and design, offering services in the fields of consulting engineering, environmental technology and architecture. With a decentralised business model, focused on the customer, Sweco has developed into a major international player (Sweco, 2016).

5.2.1 Risk Management in Sweco

Sweco’s risk management is closely related to the project management as both units work together in order to achieve the best results possible. Risk management procedure starts with the discussion between those two units and decides on the focus that certain project will take upon in terms of risks. This focus is further developed within workshops that help to identify the necessary risks that should be taken care of during the project’s implementation (Jacob Gyllentri, Group Chief Risk Management Sweco AB).

Two kinds of projects in terms of how risks are managed can be distinguished, such as where contractor is responsible for all the risks and the other one where client is responsible for most of the failures. Also, Baloi and Price (2003, p. 264) have distinguished between these two perspectives how risks are tackled. However, when Sweco does projects, it is usually indicated in the contract who is responsible for what,
and that eases the work of Sweco as they can concentrate on other matters and not as much on materials delivered by third parties.

Sweco’s risk process: risks are identified, necessary guidelines and policies are created, these are implemented in the organisation and monitored at several different levels, and a report is submitted annually to Sweco’s Executive Team, the Audit Committee and the Board of Directors (Annual Report, 2015).

5.2.2 Project Risks and Decision Making

The project risks that Sweco encounters are decided in the beginning of the project and once all the documents are submitted, they follow up during all the project, in order to know if there are any risks the client should be aware of. This risk monitoring allows Sweco to always be on track of all the necessary measures that should be taken in case of failure.

The project risks put all the responsibility on the project manager as the main decision maker in the hierarchy, and only the risk manager of the project with his/her analysis can impact this process. The guidelines and procedure of project risks management are according to ISO 31000 (Risk Management) standards and thus all the documents are conducted from the existing framework which consists of simple steps that show the order how risks should be tackled (identification, analysis, assessment, etc.). The construction process is followed up until it is delivered, however, risk manager “helps project manager to systematically handle risks of all sorts in all phases of construction” and then the responsible one becomes the coordinator of environmental quality (Jacob Gyllentri).

5.2.3 Green Building in Sweco

Social sustainability plays a major role in Sweco’s operations, as it’s their goal to meet human needs; this while the environmental dimension sets the boundaries and the economic one gives the means to realize their objectives. This summarizes the view of Sweco on sustainability. Sweco has a growing reputation for embedding sustainable thinking and design, making sustainability a mainstream requirement, and adding value for clients as well as the environment. Working with the latest technologies to enhance the efficiency, in both new and existing buildings, to reduce energy consumption, through a range of initiatives.

Sweco has achieved several first BREEAM ‘Outstanding’ ratings across different categories of building and the highest score for buildings that they have designed and assessed. A growing part of their business is the work they do on BREEAM certification for buildings. In 2014 and 2016, Sweco was recognized by BRE as BREEAM Company of the Year. Sweco is also a leader in LEED and WELL building standards with qualified LEED & WELL’s AP located within all of their major European offices.

All major construction projects are preceded by an extensive design process during which the facility’s design and function are planned and prepared. Because circumstances differ between customers and projects, planning and design are unique to
each situation. Sweco’s planning and design managers help identify and prioritise the requirements that govern the project.

A key component of Sweco’s commitment to sustainable urban development is creating buildings with a pleasant indoor climate and minimal environmental impact. Comfort and a pleasant indoor climate are important for people’s wellbeing. Yet the design of a building also influences the ability to reduce energy consumption. Environmental certification is a way to translate sustainability practices into concrete objectives that make it easier to take the right environmental actions. Securing environmental certification for a building affects both energy consumption and operating costs. Sweco’s experts help clients identify the right certification system and provide guidance throughout the entire process (Sweco, 2016).

Maintenance and regular monitoring are important measures in preventing material damage and human injury. This is particularly important in terms of electricity, ventilation and fire-safety. Sweco is certified to perform inspections in a host of areas, including contract and electricity audit inspections (licensed by the Swedish Fire Protection Association, SFPA), as well as mandatory ventilation inspections and fire-safety inspections. In conjunction with the inspections, Sweco can also provide advice on energy savings and refurbishment needs. Substandard ventilation facilities often lead to unnecessarily high energy costs. Their experts include SFPA-licenced inspection engineers that are personally authorised by the Swedish Fire Protection Association. Some of their consultants are also licenced by the Swedish Association of Construction Engineers (SACE) (Sweco, 2016).

5.2.4 BIM (Building Information Model)

Using BIM for project and management purposes means having access to major advantages: better understanding and design, and an abundance of added-value, especially economical. Using integrated tools for analysis, simulation and visualisation right from the very early stages of a project allows them to study how buildings and cities will work. Among other capabilities, BIM involves studying the best design for a building aiming to be environmentally friendly, while also being exciting in sheer architectural terms. It also involves optimising a space based on how people move in buildings or traffic.

5.2.5 Application of Green Technology

As part of Sweco’s sustainable projects, the application of new technology, in form of materials or equipment, is part of the design and construction process. For this technology to be implemented in the projects, the actual client has to decide on the final products to use. Many of these products are tested and certified by a third party (e.g. SundaHus) to guarantee their quality and performance. Nevertheless, if such products cannot be certified by this third party, the products can be still used in the projects, if the client decides so. To avoid risk due to possible failures or down performance of the technology applied, which was the client's decision, every condition of Sweco’s work and involvement in decision making is stated in the project’s contract, transferring this way, the risks to the client. “For every risk, we do records and we forward them to the ones operating the building, for example, we have 200 risks and 190 we can handle, so
you need to be aware of this and to explain the ten risks we cannot handle” (Jacob Gyllentri).

SundaHus is a company, like others in the market, that test and certify materials for any kind of use. They work as a consultancy company for a variety of clients, Sweco being one of them.

5.2.6 The Future of Sweco and Sustainability

With every company in the market promoting sustainability as part of their core business, a strategy is needed to keep being competitive. For this reason, Sweco is tracing their future goals for Sustainability and Sustainable construction, as their projects in this trend keep to rise year by year. The need for this is immediate, nevertheless work on this area is already being done by Sweco.

5.3 Consultant / Researcher

Urban Persson, a sustainable construction consultant, has worked on sustainability issues in the construction industry since the 1990s starting as a teacher and further being involved in the formulation of the degree programme in Ecotechnology and Sustainable Development at Mid Sweden University at Östersund. He has also been a lecturer at Lund University’s Department for Building and Environmental Technology.

5.3.1 Risk Management in Sustainable Construction

As described by Mr Persson, the sustainable construction movement has changed the way risk management must be done, as considerations from the sustainable dimension have to be taken into account; considerations not only in the design process, but also in the subsequent phases: construction, delivery and operations. Moreover, guidelines for this have been outlined in the current sustainable construction standards to tackle this change. Nevertheless, as explained by Mr Persson, the industry has not applied any framework for this, pointing that the main reasons reside in the fact that the risk management process can be a complex one with time constraints. Added to that, exists the fact that projects involve temporary organizations and management of several stakeholders.

A fact pointed out by Mr Persson regarding management is the inclusion of the client into the factors of failure of the implementation of standards and frameworks for risk management. This happens mainly because the client doesn’t possess a structure adequate for the implementation of such procedures. With this, he establishes the importance that the client has in the success of the implementation of frameworks and procedures.

5.3.2 Sustainable Construction Obstacles

With a movement that is shaping how construction is done, a lot should be achieved still, according to Mr Persson. Starting from classes, where more about sustainable construction should be learned going to the construction companies’ organisation. When asked about the difference between implementing sustainable construction in big
companies compared to small and medium ones, he pointed out that the main factor is the knowledge that the big companies have and manage, unlike the others, where the knowledge is low or not present at all. Added to the above, a reorganization that fit the sustainable principles is needed to implement sustainable projects, as explained by Mr Persson.

The implementation of sustainable projects is still in hands of the clients, as they take the decision on how much to invest in their projects, being the financial factor one of the main obstacles in green building. There is still no legal binding to codes or standards, as this work still has guidelines, leaving to the client's discretion the implementation of green requirements in their projects. "The main thing is client, because client decides what kind of project and what kind of sustainability focus the project should have and client pays the consultants and construction companies, so the focus should be on clients and not construction companies and consultants" (Mr Persson). So, the client is the most crucial part that moves the market and companies operating in built environment can only suggest their clients to apply sustainable construction in their projects. Built environment is a conservative one that has major changes only over long periods. Such changes must be done in a swifter way to achieve a real sustainable development with a reduction of the great impact that an industry as the construction one has.

5.3.3 Sustainable Construction Risks

Mr Persson mentioned that the risks in sustainable constructions include the implementation of innovative technologies, which need testing, not only of their quality and performance, but also of the interaction of such technology with other new technology or current one. "You have to be very careful with all the new products that come in the market, because you have to test them with old ones, or you have to test new ones with new or mix them together in order to know if they react chemically" (Urban Persson). With this, research and development should be increased in order to achieve major changes in terms of environment and society as well as product declaration documentation of what is used in buildings. "It is the biggest risk, because we still use bad things in our houses and we are using things that we need to manage in future as they might be bad for our health or environment, but we do not know what kind of materials we are using because they are lacking product declaration documentation" (Mr Persson).

Also, one of the main risks, is the attempt of implementing, and further achieving, the three dimensions of sustainability in a construction projects, meaning achieving social, environmental, and economical sustainability. Reasons for this are set in lack of knowledge, expertise and experience in sustainable construction, as those are advanced, and the financial cost that would require. Also, at this point, with innovative technology entering the market and the need of testing it, and the improvement of the research and development in the construction industry, makes the economical dimension of sustainability, still a great challenge to overcome.
6 DISCUSSION

During the literature review of sustainable construction and risk management in construction industry a lot of general findings were discovered, however, the lack of connection between those two and the impact of sustainable buildings in general was felt. By interviewing experts from the industry, it allowed us to find out specific details and inconsistencies between literature and practical world. We intend to display how successful examples of sustainable construction implementation can help us to improve the model of risk management.

Skanska is one of the leading construction companies in sustainable development in Sweden, which is the reason why it is the main object in our discussion. However, Sweco has showed great deal of experience in the field as well, so it is discussed in the second part of this chapter in order to later combine the knowledge from both companies and improve the existing process of risk management in relation to green buildings and high-performance buildings. By combining the data gathered from both companies and adding the view of independent consultant, we aim to fulfil the purpose of the study to understand and learn from good practices in the industry how risks are tackled.

6.1 Skanska

Skanska shows a great level of expertise and experience when it comes to Green Building. Their history and their investment into this trend has set them in the forefront of sustainable construction. While many other companies seek to comply with local codes and/or standards, Skanska aims to go further; it is shown with their strategic tool, as they call it: “Skanska Color Palette™”. By applying the tool projects are raised to new levels, achieving impressive results. Setting their strategy strongly in sustainable development, they thrive in the market, understanding its present and future needs. This is aligned to what was stated before by Maduka et al. (2016, p. 1), pointing to the necessity of the construction industry to adapt sustainable principles into their operations.

6.1.1 Green Risk Management

Going deeper in Risk Management in Sustainable Construction, as is the main purpose of this thesis, the process they overtake is explained. To understand the success in this area, it is necessary to identify the steps that they take in order to reduce the risks due to the implementation of green standards. As described in the theoretical framework, some authors have pointed out major risks that companies and projects have due to the implementation of green building (Kibert, 2013, Nutter, 2016). In Figure 10, these risks are paired up with some key actions that were identified from Skanska.
Figure 11. Skanska’s Green Risk Response Actions.

Regarding the risks in green building identified in the theoretical framework and the steps Skanska has taken in order to solve these obstacles, it seems they have achieved a solution. The main obstacles that remain are the higher costs of this type of construction because of the short-term perspective that clients have, this derives from traditional construction. This problem was also mentioned by Kibert (2003) when stating that for sustainable projects a life cycle costing is needed, which involves not only the construction costs, but also the operation costs in the building’s operational life, making this a long-term investment rather than a short-term; an obstacle when the projects are assessed in a basic project life cycle, which happens usually in construction as explained by Archibald et al. (2012, p. 6). These obstacles have been overcome through time due to the experience that the company has gained and the expertise of the people working in it as for some time; they know what they can and cannot do regarding the green building. Mr Haglind comments that “you do not have to add a lot of extra money, you just have to design it a bit differently from day one” and if you do not have to change requirements during the construction then green buildings do not imply extra costs. As described in theoretical framework by Akintoye and MacLeod (1997, p. 31) that risk management in construction projects is usually applied according to experience and experts’ judgement. Nevertheless, when it comes to the Deep Green projects the obstacles remain, as to achieve this level, an even higher investment is needed.

When it comes to the requirements set for green building and compliance to codes and/or certifications, the development of the tool Colour Palette sets a first step of classification according to the level of requirements for green projects. Nevertheless, it is not the only tool. Skanska has implemented what they call Green BIM; that is a Building Information Modelling (BIM) applied to green construction. With the
application of both tools, the project requirements can be evaluated in a model and later on specified; according to what the assessment says this can be done within Skanska’s operating limits, thus to guarantee their final product. The requirements, that include energy and water consumption, use of materials, carbon emissions and waste, are achieved by the use of current and new technology applied to construction. Such requirements form part of the areas that are in a need of change in the construction industry, as described by Kibert (2013, p. 491).

Figure 12. Flow diagram for testing new green technologies.

In the flow diagram shown above, the process that new green technologies that are brought to Skanska should go through before being even recommended for the use is described. As shown in the diagram, each technology has three stages development in Skanska: New Green Technology, Green Solution and Standard Construction. Having this process guarantees that risks due to new technology for green building is lowered in terms of performance and quality; nevertheless, it is an exhaustive process that consumes not only time but money; according to Gan et al. (2015, p. 63) these processes need skilled and qualified professionals to make it possible. Additionally,
every technology, material or equipment, applied is followed up to measure its performance and gain knowledge in which situations it works the best and in which situations to apply it in future projects; a lessons-learned procedure.

Each new technology follows a thorough process, from providers’ specifications, lab testing and experiments and mock-ups to field testing; all of these processes are carried out before reaching actual projects. With this Skanska can guarantee the performance of the materials and equipment used in the buildings. Not every technology brought to the market is used by them, few of the new materials or technology are tested and used by this company. Furthermore, a follow up on the buildings is made during their operation phase; maintenance, energy consumption and overall performance are checked.

6.1.2 Green Risk Management in the Project Life Cycle

With all the explained in the previous section, we can model the steps taken by Skanska on how they reduce, avoid or even prevent the risks before identified in relation to the project life cycle. With an overall project risk management process that has not being affected by Green Building, the steps towards tackling green risks are taken outside such processes. For this it is necessary to highlight, related to the project life cycle, when such steps are taken.

![Figure 13. Project Phases and Processes – Skanska AB.](image)

As shown in Figure 12, a first step is taken outside the project life cycle; the process described above in the Green Concept Plan, is carried out for the overall company, enabling a portfolio of recommended materials, equipment and overall technology that can be applied to future projects. When a project is being initiated, the Green BIM takes place, setting the project requirements and project goals to enable stakeholders make proper decisions. Achieving such requirements is a guarantee as the BIM also includes an integral design; meaning that new technologies, materials and the architectural design are integrated to forecast, with proper security indexes, the final performance of the building, reducing possible risks related to code, standards or requirements compliance.
Within the project life cycle, the project risk management is carried out. Here, depending on the level of impact of the risk, the assessment and further decision of the actions to be taken are made by different actors in the company, as explained in the Risk Management Decision Making Framework of Skanska. It is important to emphasize that the risk identification and assessment is carried out based on previous experience and expert judgement, being aligned to what was stated by Akintoye & MacLeod (1997, p. 31). Nevertheless, in Skanska, this is combined with strict procedures established by the company. After identifying and assessing the risks, actions are taken throughout the project construction process until achieving the final product. Finally, after delivering the product, a follow up is made, not only to assure the compliance to the requirements, but also to gain knowledge for future projects on how the materials, equipment and overall technology applied can be used further on in future projects.

As explained by Skanska, supported by the statements of Kibert (2013, p. 480) and Lam et al. (2015, p. 63), there is still fear of the higher investment in green building compared to traditional construction; nevertheless, as the market keeps demanding such type of constructions, such a fear will decrease.

### 6.1.3 Skanska: Conclusions

To achieve such level of understanding and competence in green building, a great amount not only of knowledge but also expertise is needed, both present in Skanska. Even though, in the general practice sustainability is gaining a great importance in today's development, it is not as advanced as in Skanska’s model. Their ability to forecast, years ago, the necessity for such change in the industry enabled them to be on the forefront of such movement. Added to this, the funding in certain areas like the Green Concept Plan, allowing them to have an in-house testing unit, gives them control in every step taken on all project phases, from the inception and development to the operations; guaranteeing the end products.

Overall the process described in the previous section, allows Skanska to deal with many risks related to Green Building/High Performance Buildings; this all the way to the point of not considering such risks, but analysing Sustainable Construction as an opportunity in the market.

![Figure 14. Skanska overall process for Sustainable Projects.](image)

### 6.2 Sweco

When it comes to sustainable construction, this company complies with local codes and standards, having a good level of expertise in some of their business units, like the one in the UK in regards to BREEAM. No other business unit, as in regards of the evidence found, presents such level of expertise; nevertheless, it is said that the same model is applied in other units in Europe. Sweco promotes their services with a focus on
“building smarter cities”, providing consultancy in sustainable construction, however, the trend within the company is driven by what their clients and the market demands regarding the product.

### 6.2.1 Green Risk Management

Going deeper in Risk Management in Sustainable Construction, as is the main purpose of this thesis; to understand how Sweco is developing in this area, it is necessary to identify the steps that they take in order to reduce the risks due to the implementation of green standards. As described in the theoretical framework, some authors have pointed out major risks that companies and projects have due to the implementation of green building (Kibert, 2013, Nutter, 2016). In Figure 14, these risks are paired up with some key actions that were identified from Sweco.

<table>
<thead>
<tr>
<th>Risks in Green Building</th>
<th>Actions Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Operating Expenses</td>
<td>Risk Transferred to Client by Contract Conditions</td>
</tr>
<tr>
<td>Unachievable Project Requirements</td>
<td></td>
</tr>
<tr>
<td>Failure to Meet Green Code or Green Certification Requirements</td>
<td>BIM</td>
</tr>
<tr>
<td>Construction Schedule and Cost Impacts</td>
<td>• Testing and certification for technology with a third party</td>
</tr>
<tr>
<td>Damage to Environmental and Professional Reputation</td>
<td>• Transfer of risk to client by contract conditions</td>
</tr>
<tr>
<td>Materials and Equipment with Reduced Life Cycles or Immediate Aesthetic or Performance Failures</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 15. Green Risks Response Actions.](image)

Many of the risks, identified in the literature as risks related to green building, in Sweco are transferred to the client who is the one that takes the final decision of what to do with the projects. As such, the conditions of the project are stated in the contract to make sure to whom the responsibility will rely on. However, “not all the materials are in SundaHus database and it can take some time to check them” before knowing if they reach certain criteria in order to be applied in green buildings (Jacob Gyllentri). Sweco provides consultancy aiming to achieve sustainable construction, nevertheless they set a limit in the decision-making process; this can affect a project later on in terms of achieving sustainable requirements, either by code or standards, or the requirements set in the design of the project.

As a growing process in the industry, the use of BIM has shaped how projects are done nowadays, and this is also true for Sweco projects. With this, they manage to control the projects from the design phase, setting their objectives and requirements in accordance
of what is needed by the clients. This include the technology applied to such projects. A part of the application of new materials into their projects, a third-party company is consulted to guarantee the performance of such materials; nevertheless, this works as a recommendation to the client, who, whatever the opinion of this third party is, decides on what to use. This way, from the project point of view, risks are not tackled, rather transferred.

It is important to emphasize the fact that Sweco provides services which follow up the performance of the buildings they design and manage, not only in the operation phase but during their construction, in order to guarantee to deliver what they have offered.

**6.2.2 Green Risk Management during Project Life Cycle**

In accordance to the project life cycle within sustainable construction, Sweco deals with sustainable projects (including materials, energy efficiency and costs) in the same way as dealing with common construction projects. That means that all the sustainable materials utilised in the projects are of the responsibility of either the third party, for example, SundaHus, or the client. The most important risk assessment process takes place in the beginning of the project life cycle and is done in collaboration between the risk manager and the project manager who oversees the risk management process throughout the project. As stated by Sharma and Swain (2011, p. 109) assessment of risks, definition of actions and controls, and communication of the risks are crucial components of the process. Further responsibility of the follow up of the project is given to coordinator of environmental quality that monitors the project after its close out.

The project life cycle during its construction phase is monitored according to the contract type. There are two types of contracts where in one Sweco is responsible of all the project risks and the other one where the client is responsible. So, the contract determines all the risk assessment, if Sweco is responsible then it provides all the documentation of the risks that are covered and that should be taken care of during the execution of the project.
As shown in Figure 15, the activities described before are represented in the project life cycle. As described by Sweco’s Group Chief of Risk Management, the risk management process is not affected by the application of sustainable standards; rather the model presented above describes the overall process of their projects, adding only the recommendation of new technology or innovative designs for achieving sustainable standards.

6.2.3 Sweco: Conclusions

The recognition of sustainable construction in Sweden, that has been promoted by the leaders of the industry and the authorities, has driven Sweco to gain the knowledge and experience necessary during these last five years. Their experienced employees and contract types utilized, and the use of specialized partners in terms of material testing, allow the risk management process to be carried out in the traditional way and, thus, see green buildings and high performance buildings as rather opportunistic projects than threats to their company.

Figure 16. Project Phases and Processes - Sweco.

Figure 17. Sweco’s overall process for Sustainable Projects.

6.3 Risk Management Compared

For the comparison of risk management of these two companies, important facts should be mentioned; both companies not only operate in Sweden, which was the focus of this
thesis’ multiple-case study, but also they operate in other European countries. With the two companies in the same industry, a big difference to emphasize is the fact that Skanska builds the projects it develops, while Sweco’s scope stays in the managerial dimension. Both companies having their beginning at the end of the XIX century, have amassed a great amount of experience in the built environment, being suitable subjects for this thesis.

Table 2. Company’s Comparison - Services Provided.

<table>
<thead>
<tr>
<th></th>
<th>Skanska</th>
<th>Sweco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Management</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>Construction</td>
<td>★</td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
<td></td>
<td>★</td>
</tr>
<tr>
<td>Sustainability</td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>

The services mentioned in the Table 2 try to describe all the range of services companies provide. As shown in the table above, the biggest difference between these companies is the construction services, as Sweco concentrates in consultancy. In regards to the R&D that Skanska has, it can be deduced that this can be done within the company due to the considerably bigger size they present. Because of these main differences, a comparison in terms of revenues and number of employees for example, may not be possible, nevertheless, a comparison in the risk management processes, specifically in sustainable projects can be made.

6.3.1 Risk Management in Sustainable Projects

As described by both companies, the sustainability trend has not changed the way the risk management process is done. Moreover, the changes due to sustainability take place in other management processes that affect the project. It is important to clarify that each company implements their own risk management processes based on common standards such as the one described in the theoretical framework from the PMBOK (2008), adapted of course to their organization. For both companies, the risk management process represents an important step towards a successful project, highlighting its importance in construction projects as stated by Iqbal et al. (2015, p. 67).

Units within the companies have been established in order to support the projects in the identification and further assessment of any risk. Moreover, frameworks for decision making about the actions to take have been developed, taking into consideration not only the impact of the risks identified, but also the size and importance of the projects and the financial investment. It is important to emphasize the fact that risks are taken in relation to certain conditions (known risks), as explained by Floricel and Miller (2001, cited in Caron, 2013, p. 8). For the unknown ones, no specific processes are taken, but tackled from the decision-making frameworks stated before, setting that as a contingency procedure in accordance to the PMBOK (2008, p. 275).
Although their risk management processes have not changed, they do tackle the risks related to green building, identified by some authors like Kibert (2013) and Nutter (2016), and they do it in different ways. Their strategy can be based in the experience and the tools and processes they developed for this, reinforcing what was stated by Akintoye and MacLeod (1997, p. 31), where they explain that risk management in construction projects is usually applied as from previous experience and judgment of the experts. While Skanska presents an advanced knowledge and a clear strategy in regards of Sustainability setting themselves in the forefront of the industry going further of what the market requires, Sweco seem to comply with market standards.

Table 3. Comparison of Actions taken in regard of Green Risks.

<table>
<thead>
<tr>
<th>Higher Operating Expenses</th>
<th>Skanska</th>
<th>Sweco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expertise and Experience / Risk</td>
<td>Transferred to Client or equipment supplier. Clearly defined assumptions how the building shall be operated</td>
<td></td>
</tr>
<tr>
<td>Unachievable Project Requirements</td>
<td>BIM / Colour Palette</td>
<td></td>
</tr>
<tr>
<td>Conservative assumptions, second opinions on solutions</td>
<td>Transferred</td>
<td></td>
</tr>
<tr>
<td>Damage to Environmental and Professional Reputation</td>
<td>Expertise and Experience / BIM / Communication Plan</td>
<td>BIM</td>
</tr>
<tr>
<td>Construction Schedule and Cost Impacts</td>
<td>BIM</td>
<td>BIM</td>
</tr>
<tr>
<td>Failure to Meet Green Code or Green Certification Requirements</td>
<td>BIM / Colour Palette</td>
<td></td>
</tr>
<tr>
<td>Conservative assumptions. Clearly define what happens if targets are not met.</td>
<td>Transferred</td>
<td></td>
</tr>
<tr>
<td>Materials and Equipment presenting Performance Failures</td>
<td>Green Concept Plan</td>
<td>Testing by Third Party / Transferred</td>
</tr>
</tbody>
</table>

As indicated in Table 3, Sweco transfers most of their risks to the decision makers, commonly the clients, stating such conditions in the contract to avoid legal problems if anything is done contrary to their advice. This does not mean that they do not recommend and/or advice sustainable practices, but they show flexibility to adapt to their clients. This decision-making includes the higher investment that is made in green building, being still an obstacle in the market.

As for Skanska, as they have been developing their strategic tools and procedures since a long time, using them as a construction standard, the compliance with the market codes and standards in all their projects is easily achieved; and as described by them, their clients don’t see any more the higher investment as a problem as they have changed their mind-set to a long-term view. This last applied to their projects that comply with the minimum standards (Skanska’s Vanilla Projects), as for their more “green” projects, still the obstacle of the highest investment remains.

One of the risks more debated in theory in terms of sustainable projects is the implementation of new technologies, including new sustainable materials and high performance equipment, stated by Nutter (2016, p. 6), Kibert (2013, p. 479) and Gan et al. (2015, p. 63). As both companies recognize the implementation of such new technology, they tackle this problem even before the beginning of the projects in similar ways. For this, Skanska has implemented a unit within the company to test and approve any new technology that they think can be used in their projects, for later recommendation of the use of them to their project managers. Technology that does not
go through this process is not even considered. This way they can guarantee the quality, not only of the product, but of the project itself.

On the other hand, Sweco utilises a consultancy company, a third party, to analyse the quality and performance of new products. With the approval of this third company, products are advised to the clients for its use in the projects. Unlike Skanska, if the product is demanded by the client, even without the approval of the third company, it will be used in the project. The risk then is maintained, as if any failure appears further in any phase of the project, the project may be subject to problems in reaching the requirements set in its design, and moreover, a major performance failure can produce a non-sustainable building. In any case, this risk, as mentioned before is transferred to the client, who takes the final decision. However, as explained by Lam et al. (2010, p. 655), uncertainty and risk associated with new green technology is common.

As from the evidence collected, an important aspect to stress out is the project life cycle point of view. As mentioned throughout this thesis, attention to the operation phase of the projects was made, as it was identified as one of the phases most disregarded in project management (Archibald et al., 2012, p. 6); nevertheless, both companies take into consideration this phase, evaluating the performance of the end product to guarantee the requirements set at the beginning of each project, thus, lowering one of the risks mentioned before.

Overall the process on both companies is similar, with a project risk management unchanged by the fact of dealing with sustainable projects. As said before, the green risks are tackled outside this process, adding more procedures and conditions to achieve the necessary requirements. Nevertheless, big differences in such procedures are present, varying the organization’s structure. A fact to consider is that the expertise and experience presented by companies, according to the data collected, differ. This can be seen not only on how projects are managed, but also on the tools that have been developed and the objectives that drive the strategy.

**6.3.2 The Consultant / Researcher Point of View**

As explained in the theoretical framework, there are several reasons why risk management should be included within construction organizations: risks alter by time due to “changes in legislation, effects of related authorities, adoption of non-standard building contracts, and uncertain site conditions” (Zou et al., 2010, p. 854). Added to such reasons, Mr Persson explained that, as the construction industry is conservative, any change done in such industry brings many risks. Moreover, as he continued, there is a lack of knowledge in the industry’s upcoming professionals regarding new movements within the market; it is because the formation process of the professionals in the built environment doesn’t integrate new trends, in this case, sustainable construction.

In regards of the obstacles presented in sustainable construction, one of the biggest one remains to be the financial one, as more sustainable projects require higher investments. However, this is not the only obstacle; according to Mr Persson, even though there have been materials introduced to the construction market since the mid-60s, there have been always issues regarding to this, which makes necessary to increase material testing and certification. With this, research and development should be increased in order to
achieve major changes in terms of environment and society as well as product declaration documentation of what is used in buildings.

Knowledge in Sustainable construction is necessary for a successful implementation of such trend in a company’s model; which in Mr Persson’s opinion is the main difference in regards of large companies in the built environment and small and medium ones. With experience in the industry and specially in the Swedish market, Mr Persson commented on the two companies that are part of this thesis, describing Skanska as moving forward on the sustainable construction movement and Sweco’s merges and acquisitions being part of their development in such area.
7 CONCLUSIONS

The main objective of this thesis is to understand if companies operating in built environment in Sweden, dealing with sustainable construction projects, can identify the risks related to these practices, as well as to understand what are these challenges. Moreover, the thesis aims to examine, if the risks are identified, then how the companies deal with them without compromising the sustainability goals of the construction process and the final performance of the buildings. The research question that comprises the aim of the study is as follows:

*How do Swedish companies, operating in built environment, identify and deal with risks associated to Green Buildings and High-Performance Buildings?*

By answering the research question, several conclusions can be pointed out. First, risk management remains very essential in construction projects, as they often fail to meet deadlines or they overrun costs (Iqbal et al., 2015, p. 67). According to Serpell et al. (2015, p. 202) there is still a lot to achieve within the area of risk management in construction projects due to the increasing importance of the performance and success of construction projects where consequences of risks are so relevant. However, the success of Green Building and High Performance building projects depends on the available resources of the companies as the main tool as seen from the empirical findings is the experience and expertise of the employees.

Second, the challenges identified throughout the research and, thus, possible risks in projects related to sustainable construction are as follows: *use of new technologies, new practices, knowledge and expertise, and derived of these – also the financial aspect.* The initial investment remains the most important challenge according to respondents, as projects overall are still seen as short-term undertakings, when sustainability is set to be achieved from a long-term perspective. As mentioned by Kibert (2013, p. 479), a life cycle costing is needed in regards of the investment, to make sense of it. Nevertheless, there are challenges that can be addressed, and companies in the construction industry are aware of it. Examples of this are Skanska and Sweco, companies operating in construction industry that are constantly adapting to the market demands: sustainable development being one of the biggest achievements, as the construction industry is described as one with the highest impact in the environment (Petri, 2014, cited in Maduka et al., 2016, p. 3). With this, the construction industry has developed new technologies, from modern designs to revolutionary materials and new construction practices.

Third, as this thesis intends to identify the ways how Swedish companies in construction industry manage Green Building and High-Performance Building risks, it can be stated that the undertaken processes are embedded in the organizational structure of the company, thus, having necessary testing, experiments and mock-ups in other managerial processes apart from traditional risk management process. *By having sustainable construction practices tested in other processes of the company, risk management remains the same with no crucial changes for large construction industry companies*, reinforcing the idea presented by Anderson and Anderson (2009, p. 25), that risks due to sustainability just broaden the identification and therefore the assessment processes of the risk management.
Last but not the least, the companies subject of this thesis, being aware of such challenges and risks, developed processes related to research and development to help identifying them before the project planning begins, using technology and procedures they know will turn into successful ones. This is derived from the respondents’ experience in the field and their ability to distinguish when these processes are needed. Additionally, follow up processes have been adapted and developed to measure the performance of the product, not only to guarantee its quality, but also to gain more knowledge of the use of the new technology and practices, and, thus, to provide feedback. From all the above, a model can be drawn, not only to understand what these companies do, but what others can do in order to deal with the changes in the built environment.

7.1 Proposed Model

With the empirical findings and the analysis of how companies operate, we can propose a model that can be followed in order to achieve successful sustainable construction projects.

![Figure 18. Model for Sustainable Projects - Extended Project Risk Management Model.](image)

This model does not intend to change how project risk management is done; it is rather a proposition on how it can be improved, extending it to evaluation phases that can help in the achievement of the requirements of the sustainable projects. As shown in Figure 17, this model proposes pre-project evaluation phase for all the technology that could be used to reach such requirements. Moreover, it highlights the importance of implementing a Building Information Model to ensure that all requirements from the client and from green codes and standards can be achieved; added to this, the implementation of an integral design based on the requirements for sustainable projects, avoiding this way, any change in the project in future phases, saving time and cost.

As said before, and as explained by the companies, the risk management process is not modified. Rather special attention to the risk identification and further assessment, response and monitoring, as part of the Project Risk management Loop of Control is required; this is an essential part of the project management process, since the result of it may impact not only the financial cost, but also the project performance. As a final step, regarding the operation phase of the projects, performance evaluation of the product is necessary; it is not only to guarantee that the requirements will be achieved, but also to collect data as form of feedback of the design and technology performance for the implementation of such technology in future projects.
As mentioned before, this model aims to broaden the risk management process, adding control phases before and after the project. As seen in the empirical findings, the risk management process is not modified. It is necessary to mention that the risk management process in the companies, as interpreted by the empirical findings, follows the concept of the framework before presented from the PMBOK (2008), nevertheless, those are adapted to fit the organizational and project structure of each company.

7.2 Managerial Implications

The finding from this research could result helpful for project managers and companies in the built environment. To adapt to the change that the construction industry is going through with sustainable construction is key to be competitive, and knowing the challenges and risks that are present due to this change is paramount. Increasing the knowledge about sustainable construction and green building is necessary, more specifically on how to approach such trend and manage the risks related to it. Knowledge about what are the most common risks can prove useful, so managers know what is at stake when dealing with sustainable projects.

The implementation of phases before and after the project could prove beneficial to the companies in the industry, nevertheless with this, an increment in cost and time will be present. Project managers and companies need to understand that a sustainable development, thus sustainable construction, is necessary and already happening; therefore, a change in their organizations and an increase of knowledge and expertise is necessary.

7.3 Theoretical Implications

The current study contributes to the literature by analysing how the industry is dealing with sustainable projects and therefore, providing a conceptual model that allows to review and understand how risks due to sustainable construction can be prevented by adding additional phases to the project management procedures. Such risks identified by some authors (Kibert, 2013, p. 355; Nutter, 2016, p. 6; Hill & Bowen, 1997, cited in Gan et al. 2015, p. 63; Hwang and Ng 2013, p. 276) are managed outside of the risk management process; which supports the fact described by Anderson & Anderson (2009, p. 25) where the risk management process is not modified. With the above explained, the contribution is done in the field of risk management but mainly in the field of sustainable construction management. With an unaffected project risk management process, a more complex process in the project management is implemented.

7.4 Limitations and Future Research

Several limitations in regards of the methodology, strategy, and data collection techniques can be identified. Based on a qualitative research made through a multiple-case study, this thesis can present problems of generalisability of the findings, as the case studies subjects present considerable differences, and so on, those companies could present important differences with many of their competitor in the industry. Future studies, integrating companies in the construction industry, presenting different
categories within the industry, could provide better data in order to draw a more comprehensive model, as companies could vary in size, in terms of employees, projects, revenues, etc.

In regards of the sample, access to more companies would have proven valuable to analysing and further comparing the companies risk management processes. Although the companies that form part of this study present valuable information, a bigger sample could have increased the precision of the model presented. It is necessary to emphasize that more companies in the Swedish built environment where contacted for this study, nevertheless, negative responses were received and even no response at all in some of the cases. Different communication media where used (e.g. e-mail, text and phone calls), however, just two companies responded positively and added to the study.

In regards of the techniques of data collection, access to the interviewees was through semi-structured interviews performed through Skype or phone and secondary data found in available public documents of the companies. Although we had access to the information needed from the companies, more interviews from each company could benefit the analysis of the data. Furthermore, qualitative interviews are likely to be subjective and added to the fact of the sample size, problems of generalisability can be present. Other data collection techniques could have benefited the interview as direct observations, analysis of detailed project documents or face-to-face interviews. The study included companies operating in Sweden, however, future studies could include companies from other countries where sustainability has gained more interest, in order to draw more general conclusions of the current state of sustainable construction and the industry overall.

During the research and analysis of data, some questions arose in regards of the findings, but not enough evidence was found in order to answer them or make any conclusions. This opens the door for future research in order to better understand these topics. The maturity of the company can be further analysed to understand if it plays an important role in terms of expertise and experience in sustainable projects or this can be just acquired. This could prove useful in order to understand if the adaptation of new models could prove sufficient to tackle the challenges of sustainable construction. Additionally, this model can be analysed in regards of sustainable projects in any other industry with high environmental impact and with high innovation in terms of technology and new practices.
References


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Appendix 1. Interview Guide (Company)

DEAR RESPONDENT,

Students of Umeå University of Master in Strategic Project Management are conducting research in “Management of Risks in Construction Industry Related to Sustainable Projects”.

The aim of the research is, first, to learn if construction companies that deal with sustainable construction in an environment that is demanding it can identify all the risks related to these practices, as they are constantly developing such projects. The second purpose is to learn, if those risks are identified, how Swedish companies deal with them, this without compromising the Sustainability goals of the construction process and the sustainable final performance of the product; in this case, the buildings.

We kindly ask you to go through indicative questions for the interview.

Thank you in advance!

Anete Apine & Francisco Jose Escobar Valdes
Strategic Project Management Master’s students
Umeå University
Phone: +46706902582, E-mail: aneteapine@gmail.com
### 1. GENERAL INFORMATION

1.1. Name ________________________________________________
1.2. Company/Organization ____________________________________________
1.3. Age ____________________________
1.4. How long have you worked in construction industry? ________________
1.5. What is your education? (Tick your answer)

<table>
<thead>
<tr>
<th></th>
<th>College</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economics/Business</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Law/Politics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.6. Do you have academic knowledge about risk management/project management? (If yes, please specify) yes no

1.7. Name of the project:

________________________________________________________________________

1.8. Role within the project:

________________________________________________________________________
3. INTERVIEW QUESTIONS ABOUT RISK MANAGEMENT

1. What do you think of risk management in your company?
2. How do you evaluate risk management implementation in terms of cost, time and necessity?
3. In what phases of project do you normally apply risk management (identification, assessment, response)?
4. Did you participate in risk management?
5. What types of risks did you assess in the project?
6. How do you decide who is responsible for identified risks/ do you specify those responsible in contract?
7. What risks are mainly detected during the project phases?
8. How long are you responsible for the project related risks/ do you still have to overlook them after the construction is finished?
9. When your responsibility ends in the project?
10. Are there any specific risks related to sustainable construction like, for example, specific material risks?
11. How do you deal with these risks?
12. What does the risk mean to you?
13. Do you have budget set aside for unforeseen risks?
14. Is there anything else you would like to add you think is important when identifying, assessing and taking response in risk management?
### 4. INTERVIEW QUESTIONS ABOUT SUSTAINABLE PROJECTS

1. What’s company’s view in Sustainable Construction, Green Building, and High Performance Buildings? Do you differentiate these concepts?
2. For how long your company has been involved in Sustainable Construction? Why did you implement Sustainability?
3. How would you describe company’s track record in Sustainable Construction projects? Have they been successful?
4. What are the main obstacles the company has faced when developing such kind of projects?
5. Is the company involved in the design, planning and execution of Sustainable Construction Projects? Or only specific phases?
6. Researchers in the Sustainable Construction field agree that many of the risks of sustainable construction are related to the performance of the so called “green” materials and new systems that are specified and developed specifically for this type of projects. Do you agree with this?
7. What would you say are the biggest risks in Sustainable Construction? In what do you base the identification of those risks?
8. In terms of materials and systems (or the overall technology) that can be applied to High Performance Buildings in Green Construction to achieve the Sustainable goals, what are the main problems or obstacles the company has faced?
9. One of the project phases commonly overlooked in terms of project management processes is the Operations Phase – after the close-up and commissioning of the projects. How the company deals with this phase?
10. Many of the failures in performance of the “green” materials and new systems occur during this phase, presenting such failures as a major risk for the project. How does the company deal with these risks?

Thank you for your time!
Appendix 2. Interview Guide (Consultant)

Interview Guide
Sustainable Construction and Risk Management

1. Can you tell us about yourself and your research and work in Sustainable construction as consultant?
2. How would you comment on Sustainable construction affecting risk management?
3. Have you worked with Skanska or Sweco, if yes, what were your insights of their working style and would there be anything you as consultant would suggest them to change?
4. What would be your comparison of big construction companies and SME’s in the industry, are there great challenges that either of them face in terms of risk management implementation?
5. What in your opinion are the success factors of implementation of sustainable construction?
6. How do you see the future trend of the Sustainability in construction, will people become more open and will demand it more?
7. Would you say there are some specific risks in Sustainable Construction that should be taken into consideration differently from traditional risks?
8. In terms of materials and systems (or the overall technology) that can be applied to High Performance Buildings in Green Construction to achieve the Sustainable goals, what are the main problems or obstacles that can be faced?
9. One of the project phases commonly overlooked in terms of project management processes is the Operations Phase – after the close-up and commissioning of the projects. What would you say about it?
10. Is there anything else you would like to add you think is important when identifying, assessing and taking response in risk management?