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Qualitative Risk Analysis & Risk Response Planning For Construction Project

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Abstract: Projects within the development sector is characterized as fragmented, temporary and sophisticated which inherently brings upon risk exposure. Decision makers within the industry need reliant access to information and knowledge so as to manage risks during a sufficient and systematic way. Thus, the implementation of an efficient risk management in reference to managing associated project risk knowledge may facilitate successful construction project endeavors. The purpose of this master thesis is to explore and evaluate project risk management within the Swedish housing industry, with the stress on the attitude of Swedish contractors. The aim is to look at the popularity and practical adoption of risk management so as to investigate how project knowledge is employed within the process. The methodology consists of a literature review on risk management fundamentals, the various risk attitudes and knowledge management in reference to risk. Data collection and analysis are based on a mixed method approach during which conclusions are made in reference to theoretical groundwork. The empirical data is collected through the usage of a web survey and in-depth semi structured interviews with key professionals within the Swedish housing industry. The results from this research indicate that theoretical models and processes for risk management is fairly unknown within the industry, analogous methods are used within respective organizations but the sharing of definitions and ideas within the industry are absent and therefore the methods aren't as structured as described in risk management theory. However, findings suggest that the perception of actors within the industry regarding risk and therefore the risk management process is one among high importance for obtaining project objectives. Furthermore, findings indicate that the interplay between knowledge- and risk management and therefore the incorporation of those processes is underutilized among the contractors and developers.

Index Terms **- Risk Management, Qualitative Risk, Quantitative Risk, Construction Projects, Knowledge Management.**

Management

1.INTRODUCTION

Risk management is consistent with Project Management Institute (PMI) one among the nine knowledge areas and therefore the integration of an efficient risk management is taken into account an important element and essential for project success. Construction projects are often described as tremendously complex projects during which uncertainty might arise from various sources. Risk management is there for increasingly becoming an in-depth component of the project management of construction projects during a pursuit to efficiently affect unexpected events and ambivalence. It's important thanks to the damaging consequences imposed by risk and uncertainty (Banaitene and A. Banaitis, 2012). But in recent years the industry is facing a poor reputation for managing the adverse effects of change leading to delays and a failure to satisfy quality and cost targets (Smith et al., 2006). The objective involved in the procedure of efficient risk management is to provide risk neutral decision making, which successively till end in superior performance. Systematic methods for obtaining more information about uncertainty on the project is required to realize that objective (Winch, 2010). The implementation of varied techniques and methods for risk management- and assessment will however not remove all risks but the aim is to make sure that the risks are assessed and managed during a manner allowing the general objectives of the project to be achieved (Potts, 2008).

Risk management comprises the establishment of risk consciousness, integration of basic principles of risk policy and organizational integration. This enables, through applying proactive action, the project must be constructed for ineluctable problems and an increased transparency (Schieg, 2006). It's an ongoing process throughout the whole the project life cycle as risks will continually change. Risk management is that the process of identifying, assessing and responding to risk and it's important to figure as an integrated project team from the earliest possible phases, in order to spot and efficiently affect risks once they arise (Potts, 2008). The advantages of the method are clearer understanding of the precise risks related to a project, supported decisions by detailed analysis and a build from historical data which will be wont to assist future risk management procedures. Unfortunately, many project managers have still not realized the importance of implementing project risk as an integral a part of the delivery of a project (Smith et al., 2006).

An inefficient implementation of risk management is usually caused by the shortage of formalized procedures, the shortage of continuity within the different project phases and an inadequate integration between the knowledge management and interaction between processes and parties. During the construction process the main responsibility to affect risks is laid upon contractors by deciding if the risks should be reduced, avoided, transferred or retained (Liu et al., 2007). In order to manage risk effectively the

contractor must understand risk responsibilities, risk management capabilities and event conditions (Banaitene and A. Banaitis, 2012).

1.2 PURPOSE

The overall aim and objective of this master thesis is to research the perception, attitude and practical implementation of RM within the Swedish housing industry also as exploring how knowledge is managed in reference to risk management. The objectives are going to be explored so as to succeed in the general aim of this paper are given below:

- Examine the perception and attitude of risk and RM within the development industry.
- Examine how knowledge is managed in reference to RM
- Explore the sensible implementation of Risk Management

1.3 LIMITATIONS

The focus of the research conducted during this study is on risk management within the Swedish construction industry, thus including the attitude of both developers and contractors in small and large organizations, in terms of knowledge collection from the conducted survey. However, the emphasis within the study is placed on the attitude of Swedish contractors, thus the usage of in-depth interviews with solely contractors. Therefore, the study is going to be limited in terms of gaining an in-depth perspective from developers within the housing industry. Additionally, the research is limited to the Swedish construction sector.

1.4 DISPOSITION

Chapter one provides the reader an introduction, including background information about the research, the aim and limitations. Chapter two explains the methodology utilized in the study, and the glide path initiated by the author and remarks regarding the cogency and reliability of the research method. Chapter three presents the literature review, during which definitions and concepts are explained regarding risk and uncertainty, classification of risks and therefore the fundamentals of risk management. Previous studies and theoretical processes and ideas in the field of both risk- and knowledge management are presented, including theory in terms of perception and attitudes of risk and therefore the process of risk management. Chapter four presents the empirical result obtained by the web questionnaire and in-depth semi-structured interviews; this chapter acts because the basis for the analysis in chapter five. The results are divided into three sections, the attitude and perception towards risk, knowledge in reference to risk, and eventually the process of risk management. Chapter five includes the analysis of the empirical data; it further provides discussions in reference to previous theories and ideas and answers the questions proposed for the aim of this research. Chapter six presents the ultimate conclusions of the thesis and provides recommendation for future studies within the field of risk management.

2. METHODOLOGY

In order to research the perception and knowledge management of contractors with regard to risk also because the implementation of risk management within the development sector, an application of a comprehensive method is important. The methodology consists of a radical literature review on the topic and an empirical data collection comprising of two sources, a survey research in sort of a questionnaire and semi-structured interviews.

2.1 RESEARCH APPROACH

The qualitative approach is employed for any data collection technique or analysis procedure that generates non-numerical data, like structured, semi-structured or unstructured interviews (Saunders et al., 2009). The study during this research is conducted using qualitative data collection techniques and analysis procedures are utilized in a search design (Saunders et al., 2009). The pre study consisted of a radical understanding of the research area and therefore the formulation of research questions. subsequent step involved the preparation of a group of semi-structured interview questions also as a formulation of a web questionnaire on the idea of the theoretical framework. These measures were needed to assist achieve the aim of this study, which is to explore the perception, knowledge and practical implementation of the danger management process within the Swedish construction sector. The questionnaire was made so as to understand attitudes, knowledge and RM implementation among actors within the Swedish housing industry, and therefore the interviews enabled an in-depth examination of their views and organizational implementation.

2.2 LITERATURE REVIEW

A variety of books and articles had to be studied so as to get and comprehend various concepts and theories within the extensive literature on the topic of risk management. This process enabled the findings of existing research within the field of project- and risk management within itself and in reference to the development industry. The theoretical framework during this study covers primarily the basics of risk management, the various risk attitudes and knowledge management in reference to risk. the overall process and techniques used within risk management are reviewed so as to supply the reader with a comprehensive understanding of the topic.

2.3 QUESTIONNAIRE

The usage of a survey strategy is related to the deductive approach and tends to be used for exploratory and descriptive research. It allows for the potential collection of an outsized sum of data from a large population (Saunders et al., 2009). the aim of descriptive research is to obtain an accurate representation of persons or situations, thus describing the characteristics of the phenomenon being studied. Questionnaires is one among the foremost commonly used data collection techniques within the survey strategy. Each individual who is given the questionnaire is asked to reply to an equivalent set of questions, enabling an ingenious way of collecting responses from an outsized sample before analysis (Saunders et al., 2009) Following Kothari (2004) a successful questionnaire should be short and straightforward, the questions should proceed during a logical sequence moving from easy to harder questions whilst personal questions should be left to the top. A provision for indications of uncertainty should even be included, just in case respondents don't have a preference or don't know the solution. The variety of questions provided within the survey could also be open-ended allowing unlimited answers, two-way questions during which answers are limited to alternative responses like yes or no, ranking/rating scale questions and eventually multiple-choice questions during which the respondent is requested to settle on

the foremost applicable alternative (Phillips, 2008). The questionnaire presented during this study is conducted through a web survey design software at SurveyMonkey.com™.

An email invitation comprises sent out via email to an outsized number of Swedish constructions companies, including both small, mid-sized and enormous actors. The aim was to get an overall representation of the industry with reference to RM. There comprise 29 questions divided into three sections. the primary section comprises designed to gather background information also as reveal the respondents' perception and attitude towards RM. The aim with the second section comprises to explore how knowledge is managed and transferred within respective organizations and eventually the third section consisted of RM methods and therefore the practical implementation within the industry.

There comprises in total 43 responses out of 336 invitations, which ends up during a response rate at approximately 13%. the typical response rate for external surveys is around 10-15%. About 70% of the respondents had quite 15 years of experience within the development industry and the majority where contractors at approximately 88%, 24% where developers and a couple of ,38% comprises consultants. the dimensions of the businesses where equally represented, approximately 48% had quite 1000 employees while 52% had but 1000 employees.

2.4 INTERVIEWS

The categorization of interviews is said to the extent of ritual and structure, they will be highly structured and formalized or they'll be informal and unstructured. the sort of interviews chosen during this study is that the categorization of semi-structured interviews, i.e., non-standardized and sometimes mentioned as qualitative research interviews (Saunders et al., 2009). This type of interview allows for the generation of qualitative data within the sort of respondents' detailed answers, and investigation of sources of data within the organization. In order to validate findings from questionnaires these sorts of interviews can also be used as a neighborhood of mixed method research (Bryman et al., 2011). Hence, semi-structured interviews are often used in order to grasp the relationships between variables revealed from a descriptive study such as survey research (Saunders et al., 2009).

The advantage of employing a semi-structured interview as against a strictly structured formation is that it enables a wider understanding of the respondents' perspective and framework deprived of any influence of assumptions on the researchers' part. A semi-structured interview might also have the advantage of being more attentive than the usage of an unstructured formation, while still enabling the respondent to answer freely and spontaneously also as maintaining a high degree of flexibility (Bryman et al., 2011).

In order to understand the attitude and practical implementation of RM within the Swedish construction industry also as how knowledge is managed and distributed in reference to risk 7 interviews comprise conducted. The interview questions comprise designed to be open led to order to facilitate a discussion also as additional questions on the topic. All interviewees had quite 15 years of experience within the industry and therefore the professions where 3st site managers, 2st construction manager, 1st head of department, 1st construction engineer. The length of the interviews varied from 30 min to 1 hour, and 4 of them comprise conducted by telephone while 3 comprise interviewed at their headquarters. All respondents comprise asked for permission to be recorded during their interview and every one of them gave consent. the rationale for recording the interviews comprise in line with semi structured methodology, it facilitated more focus on the interview instead of taking notes and it strengthens the reliability of the research since quickly taken notes isn't as reliable because the recording and transcripts.

2.5 RELIABILITY AND VALIDITY

As described by Bryman et al (2011) and Saunders et al (2009) reliability refers to the extent to which the info collection and analysis procedures yields consistent results and whether the results of a study are repeatable, validity on the opposite hand cares with the particular precision of the research findings, i.e., the integrity of the conclusions generated from the research. The internal validity and reliability of the collected data and response rate depend much on the design of the questions and therefore the structure of the questionnaire. The questions must be understood by the respondent as intended by the researcher, and therefore the answers must be understood by the researcher as intended by the respondents. Hence, a legitimate questionnaire enables the gathering of accurate data. Four stages must occur so as for the inquiries to be valid and reliable, as illustrated in **Fig. 1.** (Saunders et al., 2009).

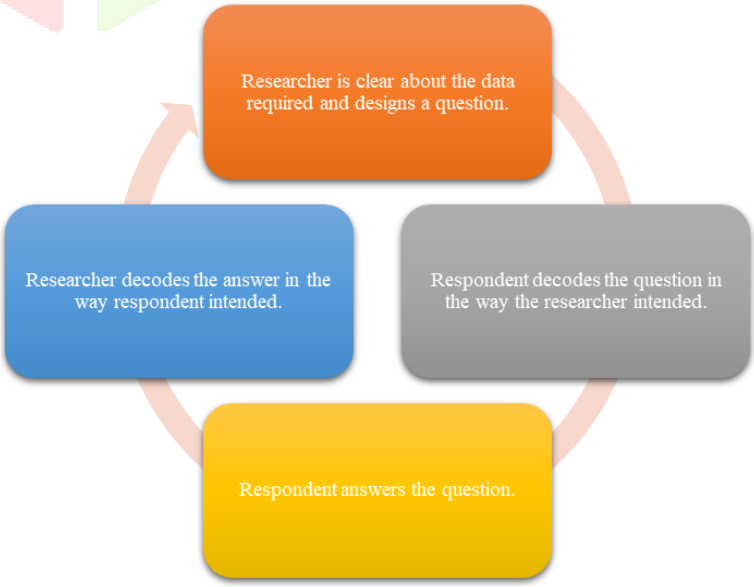

Figure 1. Four stages that must occur in order for a question to be valid and reliable.

In reference to the utilization of semi-structured interviews there are some threats which will be identified concerning trustworthiness and credibility. Preparation is vital so as to avoid or reduce potential data quality issues associated with reliability and response bias (Ibid.). The measures taken by the researcher during this study was to form bound to properly convey the

confidential nature of the study, thus protecting respondent confidentiality within the research. Another measure taken was to supply participants with relevant information and question themes before the interview, thus enabling respondents to think about the knowledge being requested and also allowing them time to assemble any potential documentation needed. These efforts should promote the validity, reliability and overall credibility of the research (Ibid.).

3. LITERATURE REVIEW

3.1 UNCERTAINTY AND RISK

The distinction and relationship between uncertainty and risk could also be described because the risk being measurable uncertainty whereas uncertainty is unmeasurable risk. it's the interaction of uncertainty on objectives that provides rise to risk, which suggests that only relevant uncertainties that have the potential to affect project objectives can become risks. In other words, a risk is an uncertainty that matters and therefore the importance is defined in reference to the actual objectives in question. However, the term risk is employed widely in sort of applications but the foremost common application of risk management is in projects, where project risks are defined as those uncertainties that would affect project objectives (Hillson, 2004).

3.1.1 DEFINITION OF RISK

Risk is usually present when making decisions on the idea of assumptions, expectations and estimates of the longer term. It characterizes situations where the particular outcome for a selected event or activity is probably going to deviate from the estimated value (Raftery, 1994). The definition of risk is diverse and may be assessed in terms of fatalities and injuries, sample of a population, in terms of probability and reliability or in terms of the likely effects on a project. One can distinguish uncertainty from risk by defining risk as being where the result of an occasion is feasible to predict on the idea of statistical probability. this suggests that there's knowledge a few risks as a mixture of circumstances as against the term uncertainty during which there's no knowledge (Smith et al., 2006). Risk is usually explained in terms of probabilities and consequences, or impact on various objectives. so as for a possible event to be considered a risk it must have a probability of between 0 and 1, which reveals a spectrum during which the event is either impossible or is for certain to happen (Loosemore et al., 2006). Hence, the occurrence of risk is present when a choice is described in terms of a series of possible outcomes and when known probabilities are often attached to line outcomes (Smith et al., 2006). Hillson and Murray Webster (2005) explain a stimulating trend when examining various official published risk management standards. They state that the definition of risk had an exclusively negative connotation before 1997, hence risk equals threat, with the term being synonymous with hazard, danger then on. Although, from 2000 onwards, the definition of risk presented in various publications in reference to risk management has changed, a clear majority of the official standards have unequivocally treated risk as including both opportunities and threats.

Risk – an uncertain event or condition that, if it occur features a positive or negative effect on a project's objectives (PMI, 2000)

Risk – exposure to the likelihood of monetary loss or gain, physical damage or injury, or delay as consequence of the uncertainty related to pursuing a course of action (Chapman C., 1991)

Risk – exist when a choice is expressed in terms of a variety of possible outcomes and when known probabilities are often attached to the outcomes (Smith et al., 2006).

3.1.2 DEFINITION OF UNCERTAINTY

Uncertainty is often deemed because the chance occurrence of some event where the probability distribution genuinely is unknown, meaning that uncertainty relates to the incidence of an occasion about which little is known except the very fact that it'd occur. (Smith et al., 2006). Thus, it is the absence of data required for a choice to be made at some extent in time (Winch, 2010). The occurrence of uncertainty is therefore present when an action results in quite one possible outcome but the probability of every outcome is unknown (Smith et al., 2006).

3.1.3 OPPORTUNITIES

It is essential to know the connection between opportunities and threats, especially within the context of project risk management (Hillson, 2004). The definition of risk doesn't necessarily refer to the prospect of exclusively bad consequences. Instead, it should also include the possibility of excellent outcomes (Smith et al., 2006). Both threats and opportunities are usually involved in any given decision situation, and both should therefore be managed. It is not advisable to consider the reduction of potential threats without also considering associated opportunities. it's simultaneously not advisable to chase opportunities without regard for potential threats (Chapman & Ward, 2003). Opportunities and threats both involve uncertainty, which has the potential to affect objectives. a chance is often defined as a group of conditions or an uncertain event that, if it occurs, would benefit the project. A threat however might be defined as an uncertain event or condition that, if it occurs, would damage the project in how. the sole difference between them is that the sort of effect on objective. Given the similarity in description, it's reasonable to bring the 2 together under a standard definition that combines the element of uncertainty with the potential to affect objectives, which is how risk is defined (Hillson, 2004).

3.2 PROJECT RISK CLASSIFICATION

Risks are often divided into differing types or classifications or categories, the important aspects of these are as follows:

Known risks: these risk events are frequently occurring altogether construction projects and are inevitable, thus including minor fluctuations in material costs and productivity (Smith et al., 2006). it's the cognitive condition of risk, where the identification of the danger source has been made and therefore the probability of occurrence regarding the danger event has been assigned (Winch, 2010). Known unknowns, these risk events are somewhat predictable meaning there's some knowledge regarding either the probability of occurrence or their effect (Smith et al., 2006). It is the cognitive condition of uncertainty, where a minimum of the danger source has been identified. Unknown unknowns, it's the cognitive condition of uncertainty during which somebody may need knowledge about the danger source and probabilities but keeps the knowledge private. The risk source isn't identified and therefore the risk event can therefore not be known (Winch, 2010). Thus, these risk events are incidents whose effect and probabilities of occurrence are unforeseeable, even by the foremost knowledgeable and experienced members of a project (Smith et al., 2006). In project risk management, events or risks with a coffee impact are often divided into the weather of trivial and expected as presented in **Fig 2.** The illustration compares the probability of occurrence of an occasion compared with its impact on

the development project. Hence, risks with both high impact and a high likelihood of occurring depend upon risk management (Ibid.).

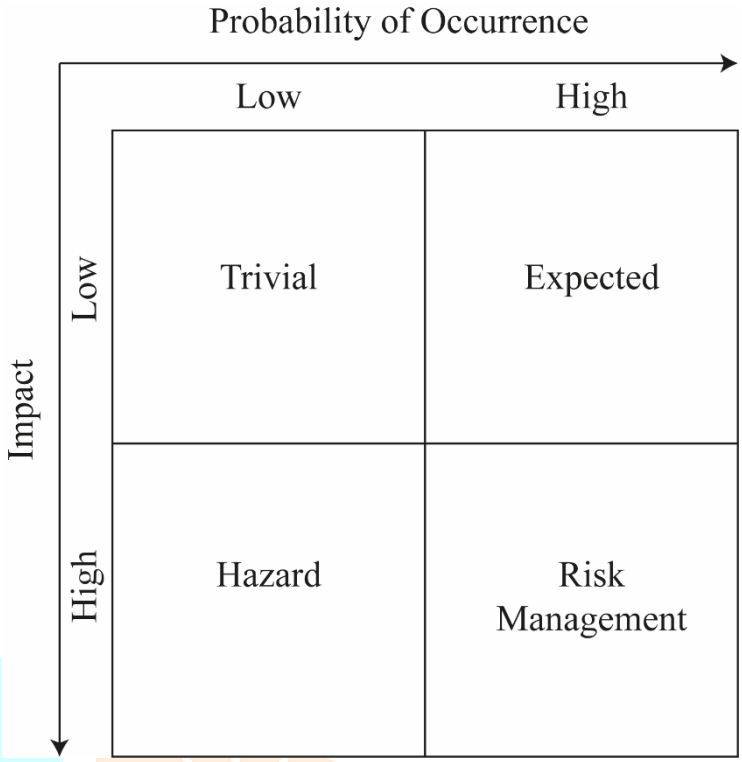

Figure 2. Risk classification in relation to probability and impact (Smith, Merna, & Jobling, 2006).

Smith et al (2006) gives an example of a hazard event with low probability and high impact, they state that these might arise but aren't considered since they're too remote actually. For instance, parts from a satellite might someday crash on a building project but few buildings are designed thereupon event in mind. However, albeit the probability could also be low the event should not be ignored if it's a high impact risk in project management. Thus, arrangement of response plans should be covered for risk events albeit the financial impact is just too large to be managed.

3.3 FUNDAMENTALS OF RISK MANAGEMENT

Traditionally risk in construction was either ignored or addressed in an arbitrary way (Potts,2008) but today risk management is an integral a part of project management (Serpella et al., 2014). The vendran et al (2004) described the concept of an efficient risk management as a continuously monitored integrated formal process for outlining objectives, identifying sources of uncertainties, analyzing them and formulating managerial responses so as to supply an acceptable balance between risk and opportunities. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives (PMI, 2000). The adoption of risk management ultimately can serve as an instrument to assist facilitate the choice making process so as to stop, eliminate and reduce the risks.

3.3.1 RISK MANAGEMENT MODEL AND PROCESS WITHIN THE DEVELOPMENT INDUSTRY

There are many methodologies or models with regard to managing the risks in various projects but the core process of risk management is comprised into four stages within the construction industry. Identification and classification of the danger sources, risk assessment analysis, development of management responses to risk and to regulate and monitor them (Smith et al., 2006). the tactic of risk management helps to watch and determine all the risks to which the project is exposed in hopes of creating an aware decision that's pursued with the coordinated and economical application of resources, so as to regulate and reduce the effect and overall probability of events considered undesirable (Dehdasht et al., 2015) Thus transparency increases through risk management and therefore the project are often prepared for unavoidable problems, also many problems are often averted from the outset through proactive measures (Schieg, 2006).Loosemore et al (2006) describes risk management as a proactive process of looking forward as against indicating a reactive framework. They state that the excellence is usually confused within the development industry where managers might think they're practicing risk management, but actually they often demonstrate a backward looking and reactive approach. Winch (2010) describes the model as being designed during a circular fashion to emphasize that risk management may be a learning process through time, using an equivalent four elements or stages as Smith et al (2006) and Hillson (2004). In literature, the core principle of risk management is that the same but the method might differ somewhat counting on the industry and organization, but the components illustrated in **Fig 3** are usually present. A systematic implementation of the method throughout the lifecycle, from getting to completion, of any construction project is required so as for the practice to be truly beneficial, thus the method must be iterative (Loosemore et al., 2006). PMBOK's model differs by incorporating risk assessment with qualitative and quantitative risk analysis. The importance of feedback within each phase is emphasized in ISO 31000, during which monitoring and review ensures that the organization monitors risk performance and learns from experience.

Figure 3. The iterative process of Risk Management (Hillson, 2004).

Construction projects are from the beginning of their existence immediately exposed to risks (Schieg, 2006). Hence, the implementation of risk management from the first stages of a project is essential thanks to the very fact that major decisions like choice of alignment and selection of construction methods are often influenced during this stage (Eskesen et al. 2004). Other reasons for investigating risk events early within the project life is that useful information about the risks might emerge enabling the implementation of a strategic approach to be defined and adopted as early as possible. this may successively help clarify internal project goals and priorities also as enabling an improved estimation of safety, budget and schedule (Reilly & Brown, 2004). By incorporating risk management into the design phase one can facilitate the identification and reduction of potential risks for the project success (Schieg, 2006).

3.4 RISK IDENTIFICATION

The identification of risk is arguably recognized because the most vital step within the danger management process (Banaitene & Banaitis, 2012). The aim isn't to get perfect predictions of future events, rather it's the popularity of potential risk sources with high impact on a particular project, should they occur. it's impossible to spot all potential risks and therefore the purpose shouldn't be to try to so (Smith et al., 2006). Thus, the intention of identifying and assessing the risks is to make sure that potential risks are assessed and managed during a manner, which allows for the general objectives to be achieved. thanks to the constant changing nature of risks throughout a project's life cycle the management of risk must be an ongoing process (Potts, 2008). Before risks are often managed, they need to be identified, and knowledge from previous experiences might apply to the present project (Karimiazari et al., 2010). The descriptions of most risk management processes emphasize the necessity to spot the risks early within the process. Chapman and Ward (2003) discusses the necessity to spot sources and associated possible responses also as secondary sources that arise from these responses. The quality of the first identification phase within the danger management process features a big impact on the success of later phases within the method (Chapman R., 2001). The initial step at the early phase of the project should form the idea by which strategies, policies, uncertainties and risks are established when it involves management and allocation (Potts, 2008). However, given that all risks aren't completely recognizable before the beginning of a project and therefore the incontrovertible fact that additional risks might arise during the implementation of the project, the identification of risk must be implemented during a manner that's in line with the progress of the project also as being forward-looking (Schieg, 2006). The PMBOK describes the importance of an iterative approach to the method of risk identification, and therefore the development and implementation of simple and effective responses as soon as risks are identified. However, they also mention that there is no significant sense of an overall iterative process to filter risks in need of cautious scrutiny.

The different methodologies regarding risk source identification usually contains checklists, brainstorming, workshops, expert interviews and analysis of various scenarios also as analysis of historical data and project plans. Furthermore, known unknowns and sources of risk and uncertainty should be documented (Klemetti, 2006). The usage of interviews with experienced project managers are often useful for solving and avoiding similar problems that might arise, all relevant participants within the project are often interviewed on factors affecting risk. The method of using past experience or historical data from similar projects provides insights about common factors during a comparison between the projects. The usage of checklist may be a simple yet useful gizmo which usually covers risks identified in previous projects and therefore the associated responses to those risks (Mhetre et al., 2016). Winch (2002) describes risk source identification being done through brainstorming sessions and that this phase generally relies on experience. Furthermore, he emphasizes the advantages of producing some quite risk register that covers all known risks and recognizes from an uncertainty and risk perspective, what has got to be managed. The authors Skitmore and Lyons (2004) described the previous method because the commonest and preferable risk identification technique. Smith et al (2006) further describes brainstorming as a way where team members within a specific project specialise in the risks specific to the project, also stressing the importance of avoiding potential group or individual biases by carefully managing the method. so as to generate an enhanced and balanced project risk source assessment, and to avoid the very fact that the group may need insufficient collective experience to spot key risks, a standard practice is to use external consultants. The process of risk source identification also as risk analysis

may generally be viewed as the most essential phases of the danger management process as long as these may need the strongest impact on the precision of risk assessment (Maytorena et al., 2005).

3.5 RISK ASSESSMENT

The identification of risk is merely the primary phase, a number of the identified risks could also be considered more significant and wish to be further analyzed. subsequent step is to work out their significance quantitatively, before the response management stage. The objective in risk assessment and analysis is to explain the danger situations as completely as possible and to prioritize them (Schieg, 2006). Generally, there are two major categories distinguished within the literature on risk assessment, specifically qualitative and quantitative analysis. the previous may be a process that consists of interviews, checklists and brainstorming while the latter is performed through a knowledge driven methodology (Banaitene & Banaitis, 2012). Risk assessment through quantitative chemical analysis defines the impact of every risk within the spectrum of high and low and therefore the probability of occurrence. Whereas qualitative risk assessment often involves the evaluation of impact and therefore the development of lists so as to further analyze the highlighted risks (X.W Zou et al., 2007). The assessment of risks through both sorts of analysis should transpire on a private level also as include the interrelationship of their effects (Schieg, 2006).

It is essential that the main predictable risk factors are quantified and effectively analyzed. The impact of potential risks could be a duration increase leading to delays, productivity decrease, and a price increase of an activity among many others. as long as resources could be shared among different projects it's going to be common that disturbance in one project may result delays in other projects. Subcontractors can also cause delays (Schatteman et al., 2008).

3.5.1 METHODS FOR CONDUCTING RISK ASSESSMENT AND ANALYSIS

Bahar et al (1991) describe the primary step in risk analysis and evaluation process because the collection of relevant data to the danger exposure, which could be historical data collected through past project experience by the contractor. Furthermore, they describe the modeling of uncertainty of a risk exposure where the likelihood of occurrence is presented in terms of probability and potential consequences in financial monetary terms. Having formed the uncertainty of varied risk events subsequent step consistent with them is to assess the general impact of those risks, through techniques like Monte Carlo simulation.

The quantification of risks is that the magnitude and frequency of every event, and each event can be a set of incidents or one incident. so as to quantify and evaluate the risks one can implement various analysis methods, everything from subjective estimation to probability analysis etc. (Williams, 1995).

One of the foremost commonly used methods for assessing risk sources consistent with Winch (2010) is the probability and impact matrix as illustrated in **Fig 4**. The classification of the risks is formed in terms of their probability of occurrence and therefore the extent of their impact. It allows a prioritization of the risks on the project in terms of them being manageable or not. PMI (project management institute) describes the probability and impact as dimensions of risk that are applied to specific events, as against the general project.

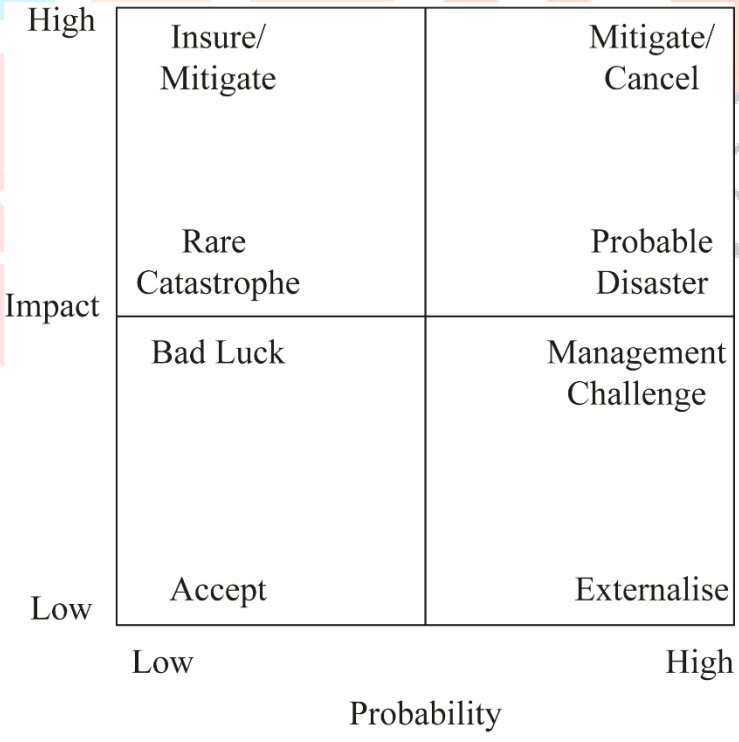

Figure 4. Illustration of probability & impact matrix (Winch, 2010).

The usage of a risk matrix as shown in **Fig 5.** is usually applied when handling static risk, i.e., risks that only have a negative effect. It resembles the probability matrix described above. A decision on how the danger is getting to be addressed is formed counting on where the danger find yourself in the matrix. Each particular project dictates what sort of risk that's acceptable or unacceptable and therefore the colors areas should be determined with the project in mind (Flanagan et al, 2007).

Probability Impact	Unlikely	Uncommon	Common	Very Likely	Likely
Negligible					
Small					
Medium					
Big					
Catastrophic					

Keep	
Partial Insurance	
Insure Against	
Refrain	

Figure 5. Illustration of a risk matrix (Flanagan et al, 2007).

By positioning various risks on the matrix, it facilitates an overall view of them, which makes the most urgent and important risks more visible. Additionally, it helps to point if the risks can be mitigated through a decrease of their probability or of their consequences (Chan & Wang, 2013).

3.5.2 QUALITATIVE AND QUANTITATIVE CHEMICAL ANALYSIS

A compilation of the foremost commonly used methods when assessing the identified risks are listed below, including an outline of everyone.

3.5.3 QUALITATIVE METHODS

Probability & impact assessment are often applied so as to gauge the likelihood of a selected risk to occur. the danger impact on project objectives is assessed in terms of opportunities and positive effects also as threats and negative effects. it's important to adapt and define the probability and impact to the precise project. The risk matrix method is often used additionally by having probability and impact as a basis for further analysis. The priority score is often computed because the average of the probability and impact and therefore the priority score range, rate and color are given for instance each risk's significance. The high priority score threats, meaning high impact and likelihood, are viewed as high-risk and could necessitate an urgent response while low scored threats might be further monitored and given attention as long as needed. Risk categorization is applied as how to systemize the threats consistent with their sources, in hopes of identifying areas with the very best exposure to those risks. The usage of this method breaks down activities into small units and creates hierarchical series of activities, additionally the method can include risk dependencies and a prioritization of them counting on how quick response they require.

3.5.4 QUANTITATIVE METHODS

Sensitivity analysis is implemented so as to spot uncertain components within the project, which will have maximum impact on the result. The aim is to seem at the sensitivity of various elements of the danger model on project outcome, by changing the values of 1 variable at a time then showing the impact on the project. Probabilistic analysis may be a method want to show the potential impact of various level of uncertainties on project objectives. It quantifies the effect of risks on project schedule and budget and it uses three-point estimates like worst case scenario, presumably scenario and finally best-case scenario for every task. Monte Carlo Simulation is most frequently used for this sort of analysis.

Decision trees may be a useful method to border the matter and evaluate various options. The usage of this method consists of decision tree diagrams want to represent the project and show the effects of every decision (Mhetre et al., 2016).

3.5.5 RISK REGISTER

The type of risks with respect to levels is shown in **Fig. 6**. The planning of the register depends on the organization, the sort of projects and therefore the people involved. it's essential that the organization creates a customized version of the register that suits them so as for it to be fully used as intended, as against being a further burden during a demanding work schedule. so as to facilitate registration, storage, management and sorting of data the register should be incorporated during a database (Flanagan et al., 2007). All the identified risks and results of their analysis, associated action plans and evaluation also because the status of the actual risk are registered within this list. Throughout the whole project life cycle there should be updates and reviews of the danger register. The register may be a central component because it facilitates monitoring and correcting progress on risk mitigation measures, it helps identify new risks and shut down expired risks also as adjusting the assessment of existing risk etc. (Potts, 2008) Risks that are no longer relevant thanks to avoidance or if they already are managed are often far away from the register alongside the associated action plans. The status of action plans and specific risks should be reviewed consistently (Cooper et al., 2005).

According to (Schieg, 2006) new additional risks, risk status and therefore the progress of the measures is required to be included. The risks that have already got occurred must be documented including the amount of injury they need produced. Furthermore, he states that an enormous a part of the monitoring of risk (which is that the last phase) is that the control system, where the responsibility of monitoring early indicators is allocated to specific people. so as for this process to figure effectively there should be a reporting and meeting arrangement in situ for the project and therefore the organization as an entire.

Figure 6. Types of risks with respect to level of priority.

3.6 RISK RESPONSE

The third step within the process of risk management signifies what actions should be taken towards the various risks and threats previously identified (Mhetre et al., 2016) the design process of risk response is defined by PMBOK because the development of options and determining actions to enhance opportunities also as reduce threats to the project objectives. This process involves the assignment of parties to require responsibility for every agreed risk response, and therefore the efficiency of this phase will determine if the risks increase or decrease for the project. Literature suggests that there are mainly four risk mitigation strategies which will be implemented so as to scale back exposure to the risks related to a project.

Mills (2001) provides an example where incorporated risk control measures resulted in an added value, showing how risk and opportunity go hand in hand. the instance he gave was an instance where a hoist was provided rather than ladders to scale back the danger of individuals falling. The additional enjoy the danger control measures taken was a rise in people's mobility and successively their productivity. Hence, illustrating an example of potential opportunity arising from risk.

3.6.1 AVOIDANCE

A response in sort of avoidance is often justified if the danger is estimated to possess serious consequence on such level which will warrant a reappraisal of the whole project (Potts, 2008). One can use avoidance to deal with risk by changing project plans during a way that creates the danger irrelevant (Klemetti, 2006), it'd be necessary to reappraise the concept or even cancel the project. This method promotes changing project plans to facilitate the elimination of the danger or to protect the project objectives from the potential negative impact. An example could be avoiding an unfamiliar subcontractor (PMI, 2000). Other examples are extending the schedule or reducing the scope of the project (Karimiazari et al., 2010). The aim of risk avoidance might also be to scale back the danger via contractual countermeasures. Additional measures which will be taken under consideration is procedural changes, regular inspections, skill and training enhancement, more detailed planning, preventive maintenance and therefore the selection of other approaches (Cooper et al., 2005).

3.6.2 TRANSFER

This response approach involves transferring the risks and consequences to 3rd parties who are willing to simply accept responsibility for its management and therefore the liability of the danger (Mhetre et al., 2016). This method is best with regard to handling financial exposure to risk. It includes the utilization of both contracts and insurance to transfer liability to other parties, for instance by contractor to subcontractor and sometimes involves payment of risk premium to the party that is taking over the danger and responsibility of the results (PMI, 2000). so as to avoid secondary risk just in case the agent (third party) fails to satisfy obligations, the transfer should only be done when the agent is during a better position to manage the danger than the principal (Winch, 2010). the most purpose is to make sure that the danger is owned and managed by the party best able to handle the task successfully (Mhetre et al., 2016).

3.6.3 MITIGATION AND REDUCTION

This approach means to mitigate the danger by changing the scope of the project to attenuate the likelihood of the damaging event occurring (Winch, 2010). Implementing risk management early within the project to scale back the probability of the danger event occurring is simpler than trying to repair the damage and consequences after the danger has passed. The mitigation of risk may be done by adopting fewer complex processes or changing conditions in order that the probability of impact is reduced, other sorts of action is adding resources and additional time to the schedule (PMI, 2000). Flanagan et al (2007) describes implementing an altered construction method and the use of other materials to scale back potential risks, or executing a replacement or more detailed planning. Additional reduction strategies include contingency planning, quality insurance, separation or relocation of activities and resources. In practice these categories might often overlap in some fashion as during this case where insurance can also be a

mitigation strategy, sharing characteristics with risk transfer (Cooper et al., 2005). However, risk reduction can only be used a couple of times during a project before the project might become unmanageable (Flanagan et al., 2007).

3.6.4 ACCEPTANCE

It is impossible actually to require advantage of all opportunities and eliminate all threats to the project, but it's possible to a minimum of remember of the threats and opportunities through the documentation and identification of them. The usage of this strategy is justified when it's not possible to reply to the danger by the opposite strategies, or when the grandness of the danger makes a response unreasonable (Mhetre et al., 2016). This risk response approach essentially means taking a conscious risk and to affect the results as they occur. this means a decision to not change any project plans so as to affect the danger or engaging in the other response strategies (Cooper et al., 2005).

As described above the danger response stage involves planning and execution and will be iterative. Having an efficient control process adjacent can make sure the correct execution of this phase (Klemetti, 2006). When it involves specifically high-impact risks but also with all kinds of risks, one among the foremost beneficial risk management strategies is to delay the choice until more information involves light (Winch, 2010).

4. RESULTS

The following results is that the data collection gathered from the questionnaire during which the questions were divided into three sections, the attitude, the knowledge, and therefore the risk management process. Furthermore, the findings and results from the conducted interviews are presented last during this chapter. The attitude section reveals the respondents' perception of risks and how they view risk management in terms of importance. The knowledge section specializes in the respondents' views on organizational learning and transfer of data. Finally, the risk management process section reveals the sensible application of risk management within the respondents' organizations.

The respondents consisted of a spread of professions within the Swedish housing industry, hence representing the general picture regarding the extent of RM perception and implementation. the bulk of the respondents in both the questionnaire and interviews had more than 15 years of experience which reinforces their credibly. Contractors comprised of 86%, developers (clients) at 23% and consultants at 4,65%. Thus, a number of the respondents worked in organizations consisting of both contractors and developers. The interviews consisted solely of contractors. An equal distribution among company sizes were attained within the data collection, leading to approx. 47% of companies with quite thousand employees and approx. 53% of companies with but thousand employees. A difference of opinion related to the corporate size will merely be mentioned when a big differentiation is often observed between them, otherwise an overall picture of the industry is going to be presented thanks to similar answers to the questions. The respondents' profession, experience, company size and work orientation is summarized within the appendix 8.3.

4.1 QUESTIONNAIRE

4.1.2 SECTION 1: ATTITUDE TOWARDS RISK AND THEREFORE THE RISK MANAGEMENT PROCESS

Q1 How does one perceive risk within the development industry?

The questionnaire revealed that the overwhelming majority of the respondent's attitudes towards risk was a mixture of both threat and opportunity, as presented in **Fig. 7.** Only two respondents perceived risk as being solely a threat, additional two respondents perceived risk as being something positive, i.e., solely a chance. However, approximately 90% (30 people) of the respondents perceived risk within the development industry as a mixture of both positive and negative associations.

Q2 what's your attitude in reference to risk?

Around 7% of the respondents perceived themselves having a risk-seeking personality while 9% observed being risk-averse. the general majority, approximately 84%, had a risk-neutral approach and having the ability to balance between avoiding and seeking risks. Hence, a correlation between the perceived personalities and their attitudes is observable.

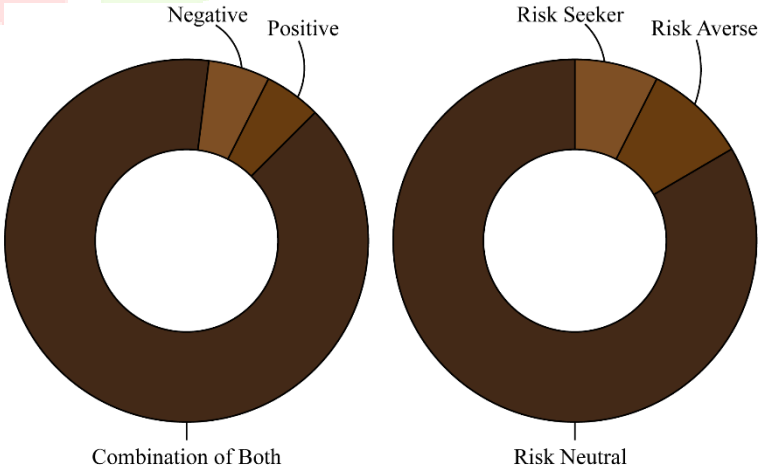

Figure 7. On the left, respondents risk perception. On the right, respondent's attitude in relation to risk.

Q3 Which stage/phase does one consider most vital for Risk Management?

The respondents answer differed quite bit when asked at what stage they considered the implementation of risk management to be most vital. the rationale for this is often probably due to the variability of professions amongst the respondents since business developers and consultants probably value the closeout phase more in reference to construction and site managers where planning and production risk is in higher priority. However, the findings still showed a pattern where the bulk considered the design phase because the most vital phase to implement risk management. Followed by production, then conceptual phase and lastly the completion and closeout phase, as presented in **Fig. 8.**

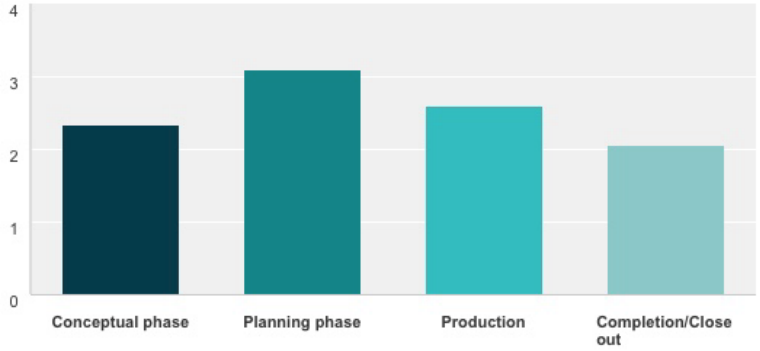

Figure 8. Respondent's opinion on which phase they consider risk management to be most important (the weighted average).

Q4 Which Risk Management process is most important?

Risk identification was perceived by the respondents because the most vital risk management process as presented in **Fig 9.** Risk assessment, risk response and risk monitoring phase were considered rather equally important with small variances in opinion.

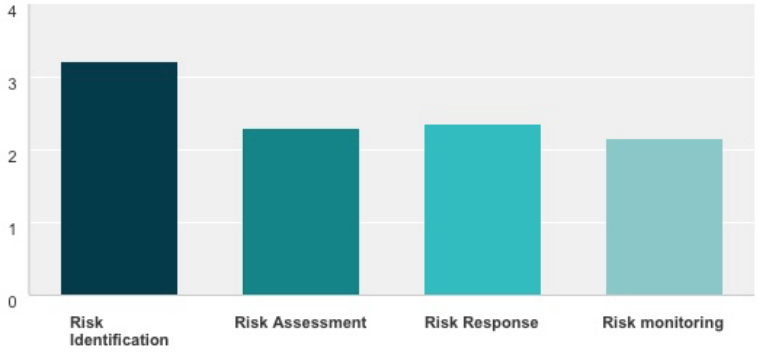

Figure 9. Respondent's opinion on which risk management process they consider to be most important (the weighted average).

4.1.3 SECTION 2: KNOWLEDGE IN REFERENCE TO RISK MANAGEMENT

Q5 have you ever read any courses in Risk Management and the way knowledgeable are you during this area?

The respondents' answers varied somewhat, approximately 60% stated that they need taken courses in risk management while 40% of the respondents didn't. Regarding how knowledgeable the respondents perceived themselves to be that they had the choice of grading themselves during a scale between 1 (no knowledge) to five (very knowledgeable). the bulk, at around 69%, chose the amount 4 which suggests they view themselves to be somewhat knowledgeable. 29% chose number 3 which suggests they were neither knowledgeable nor unknowledgeable while 2% chose number 5, i.e., very knowledgeable. None of the respondents chose number 2 or 1, which might be considered limited knowledge or no knowledge.

Q6 what's the rationale for inadequate Risk Management in your organization?

The questionnaire revealed that lack of your time was the most cause for inadequate risk management within the organizations of respondents. Followed by reasons like lack of competence and lack of resources, as presented in **Fig. 10.** The contrast between lack of information and lack of competence is distinguishable, exposing that the organizations might have the available information needed so as to enhance their risk management but since competence is one among the most important factors for inadequate implementation it's going to come short. Respondents who chose other reasons expressed that clear processes for risk management are the biggest liability.

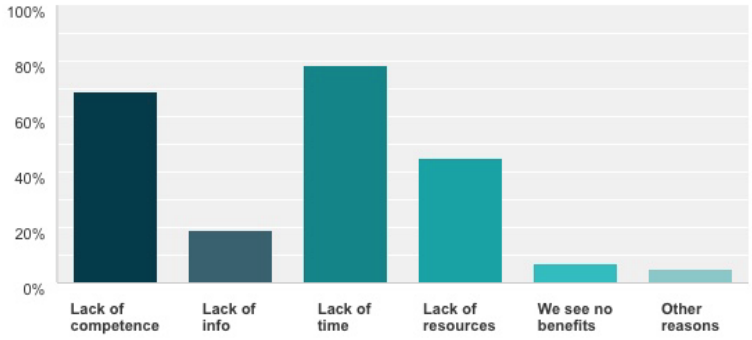

Figure 10. The reason for inadequate or nonexistent risk management within the respondent's organization.

Q7 Do your organization provide any education in Risk Management?

The respondents were asked if their organization provided any courses or other education in risk management and if so was the case, how beneficial or qualitative did they perceive them to be. Approximately 62% of the respondents said that their organization offers risk management education while 38% doesn't. However, the standard of the education offered by the organizations varied, the questionnaire consisted of a star rating scale from one star to 5 starts with regard to quality, and on the average the respondents choose three stars revealing a medium satisfaction with the education provided. A distinction between contractors and developers

might be observed during which a better number of contractors provided education in risk management within their organizations, specifically 64% of contractors provided education in RM while 40% of developers provided education in RM.

Q8 How does one draw lessons learned from previous projects?

In regards to storing lessons learned the respondents were asked how they draw knowledge and lessons from previous projects. The results unveiled that knowledge repositories and documentation also because the usage of communities of practice was the foremost frequently adopted methods used, at 64% consistent with **Fig. 11.** The respondents' main comments were that they incorporate lessons learned and feedback at gatherings like Construction Manager meetings and Site Manager meetings also as closing meeting at the top of every month. Other statements where the usage of business and management systems. Workshops seem to be used moderately at 31% while 24% of the respondents didn't use any specific methods for capturing knowledge within their organization.

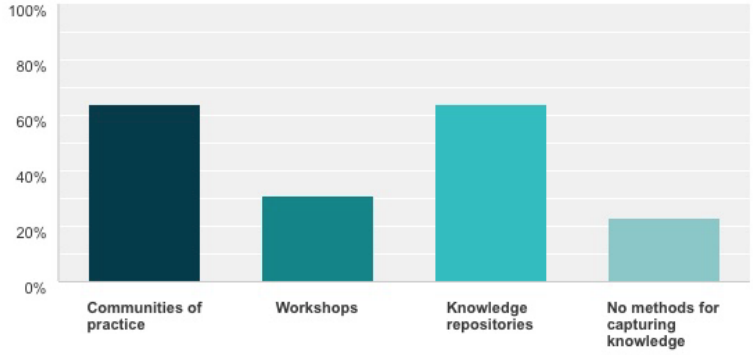

Figure 11. Respondent's opinion on how they best conclude and store lessons learned from previous projects.

Q9 What quite obstacles exist for transferring knowledge and organizational learning within Construction projects?

The respondents had the chance to freely write their opinions on the most important obstacles in transferring knowledge within their organization. a number of the foremost common comments were as follows:

- "Time and resources to handle the knowledge and database to simply identify and gather relevant knowledge and experience"
- "We do "as we've always done". More clear areas of responsibility are needed for those who face the risk"
- "A fear or unwillingness of sharing both good but especially bad experiences from the projects"
- "A lack of systemized thinking with standardization of technical solutions and production methods"
- "Knowledge tend to remain within everyone unfortunately"
- "The housing industry is extremely conservative and bad at retrieving experience and knowledge"
- "The human factor also as time, one may rather start a replacement project without evaluating the previous one in sufficient way"
- "The traditional culture and behavior of project organizations"
- "We need more standardized solutions to scale back the scope of risk

According to the respondents the most important factors preventing the transfer of data and organizational learning was the shortage of your time, lack of excellent systems, lack of resources and therefore the organizational culture and tradition. 32 respondents out of the entire 43 answered this question and the most ordinarily used words is presented in **Fig. 12**, which reveals that lack of your time was by far the foremost frequent answer.

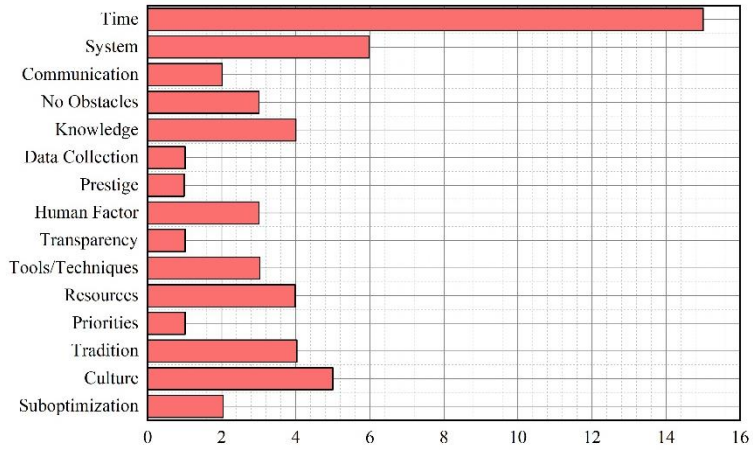

Figure 12. The frequency of the most commonly used words by respondents to describe the difficulties in learning and transferring knowledge.

For some of the subsequent questions a Likert scale was utilized in the questionnaire containing various statements and answer options ranging between "completely agree", "partly agree", "partly disagree", "completely disagree" and eventually the choice of "don't know".

Q10 How efficient are the communication regarding risks in your construction projects?

The majority of the respondents at approximately 73% chose the choice of "partly agree" for the following statement: "We have good and effective communication concerning risks in our projects". the choice to "completely agree" with the statement was chosen by 17% of the respondents while approximately 10% chose the choice of "partly disagree". However, a difference are often observed

associated with the dimensions of the development companies. The results indicate that larger companies with quite thousand employees where overall less satisfied with the communication regarding risk, compared to the smaller companies. Approximately 57% of larger companies with quite thousand employees chose "partly agree" in having an efficient communication while 22% chose "partly disagree" and 21% chose "completely agree". On the opposite hand, 87% of smaller companies with but thousand employees chose "partly agree" while 13% chose "completely agree".

4.1.4 SECTION 3: RISK MANAGEMENT PROCESS

Q11 Statement: "My organization features a clear risk identification process"

The majority of the respondents at approximately 55% answered "partly agree" while 34% agreed completely on the statement and 11% partly disagreed. No respondent answered "completely disagree" or "don't know".

Q12 How does one personally identify risks?

Approximately 60% of the respondents (25 people) stated that they identify risks by experience, 19% (8 people) was using analysis for risk identification and 12% chose knowledge as their answer as presented in **Fig. 13**. nobody of the respondents chose "Intuition" as an option nor "don't know". Around 9% chose other as a solution stating they typically combine all of the options when identifying risks or just some of the choices, like experience and analysis. One of the respondents stated that he used BF9K certification which may be a management system such as ISO certification but adapted for companies within the housing industry.

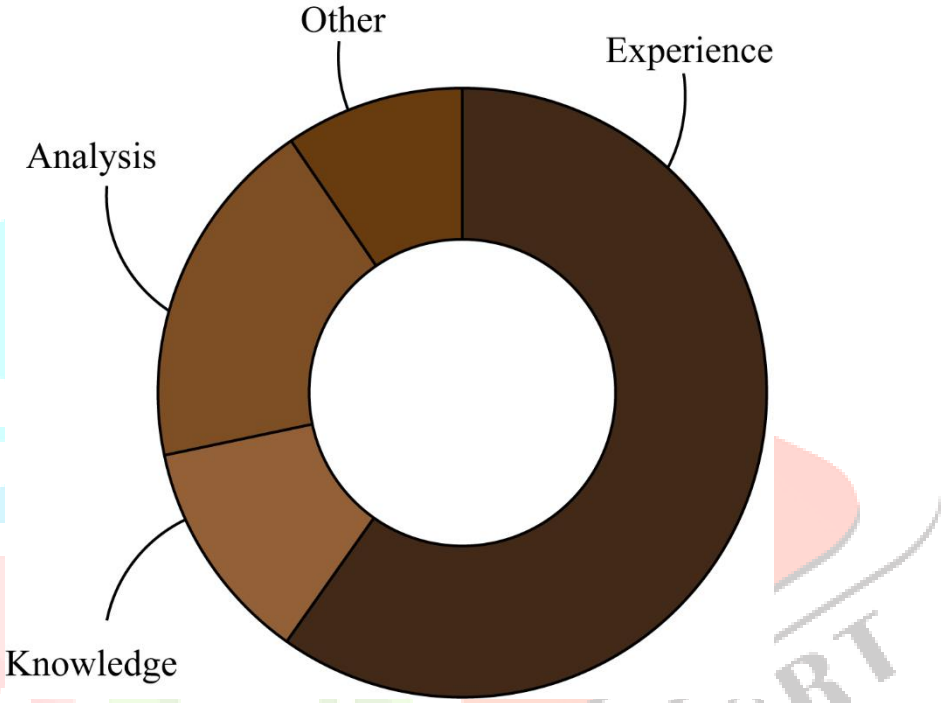

Figure 13. Respondent's answers on how they personally identify risks.

Q13 Which method does one use for risk identification?

Experience from previous projects also because the usage of checklists was equally chosen amongst the respondents, at approximately 88% (37 out of 42 respondents) and thus exposing them because the most often used methods for risk identification. Thereafter came brainstorming at around 48% as presented in **Fig. 14** and third party at 38%. Finally, source identification at around 33%, interviews at 12%, no method at 0% and other at about 7%.

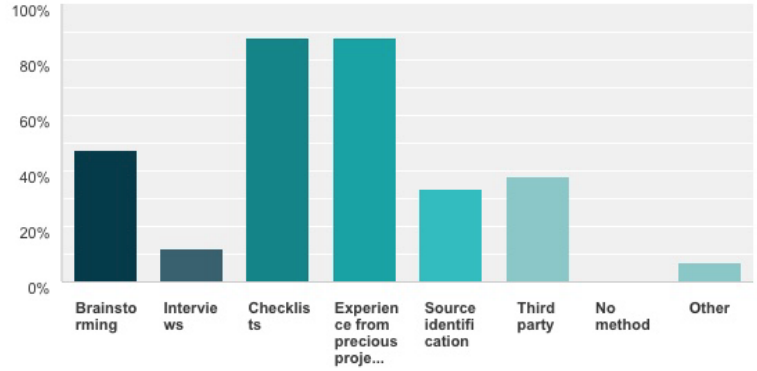

Figure 14. Risk identification methods used according to the respondents.

Q14 Statement: "My organization features a clear risk assessment process"

The majority of the respondents answered "partly agree" at about 50%, 28% agreed completely while approximately 17% disagreed somewhat. 3% chose "completely disagree" or "don't know". When comparing this statement with the previous regarding having a transparent risk identification process a 5% and 6% decrease within the percentage are often observed, regarding the options "partly agree" and "completely agree". On the opposite hand, one can observe 6% increase in the option "partly disagree" chosen by the respondents also as a third increase in "completely disagree" and "don't know".

Q15 Which Qualitative Risk Assessment method does one use?

The respondents chose probability and impact assessment at approximately 29%, followed by risk matrix at 26% and risk classification or risk register at 22%, as are often seen in **Fig. 15**. No implementation of any method ended up at 9% while the choice of "don't know" and "other" ended up at 7% each.

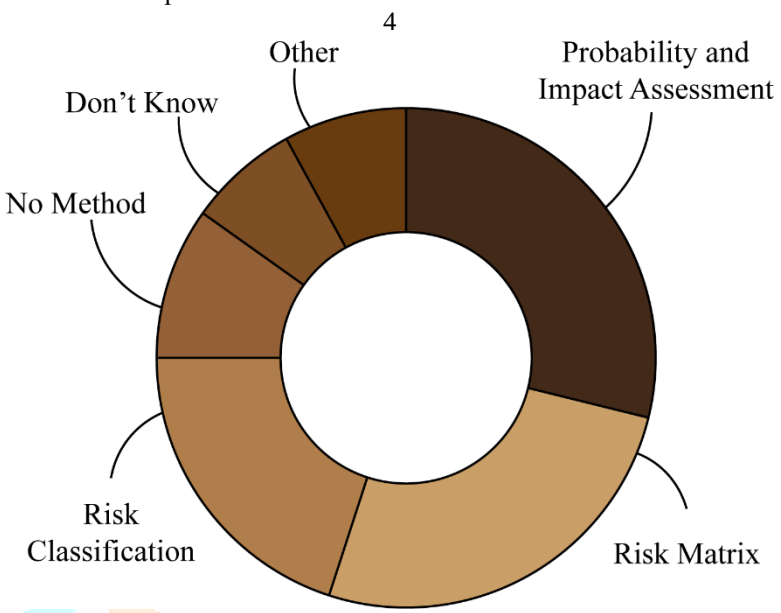

Figure 15. Qualitative risk assessment methods used according to the respondents.

Q16 Which Quantitative Risk Assessment method does one use?

Probability and impact analysis was the foremost frequently chosen option by the respondents at about 48% (20 people), followed by the shortage of any particular method used option at 20%. Sensitivity analysis also because the unawares of any risk assessment method was estimated at approximately 11% for every one among them. The usage of decision trees for risk assessment was conveyed by 7% of the respondents. Other methods used was estimated at 3% of the entire participants stating that the assessment method varies counting on things, as illustrated in **Fig. 16.**

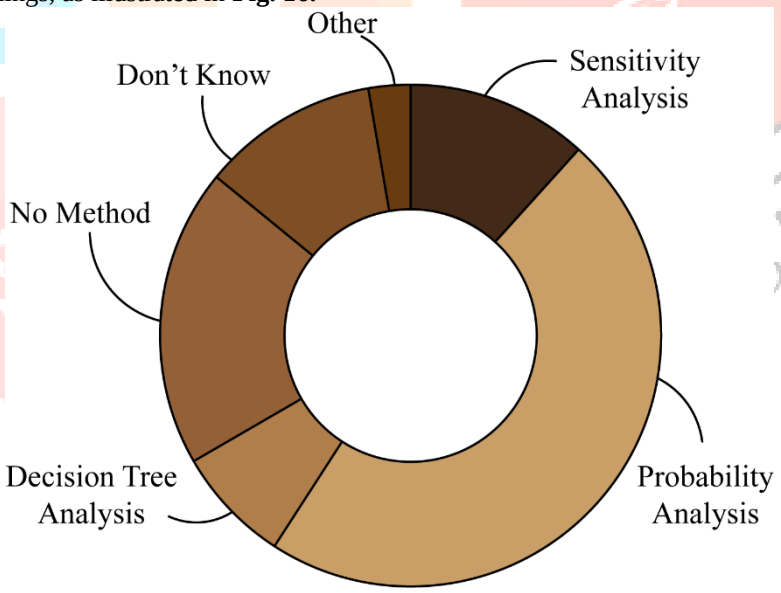

Figure 16. Quantitative risk assessment methods used according to the respondents.

Q17 Statement: "My organization features a clear risk response process"

The overwhelming majority of the respondents answered "partly agree" at 76% which is an increase in 21% and 26% as compared with risk identification and risk assessment. 17% of the respondents agreed completely at approximately 17% and about 7% disagreed somewhat with the statement. The where no responses to the choice of "completely disagree" and "don't know". Another distinction which will be observed may be a 18% decrease for the choice of "completely agree" in reference to risk identification and a 12% decrease in reference to risk assessment.

An overview of the statement questions Q11, Q14, Q17 is presented in **Fig. 17.** The respondents viewed their organizations as having best clarity with regard to the danger response process, although the they didn't fully and completely accept as true with that statement but rather moderately. The figure reveals that the bulk of the participants viewed their organization as having somewhat clear processes for identification, assessment and response to risks, hence implying that probably more might be done to implement more well-defined processes for all employers to embrace.

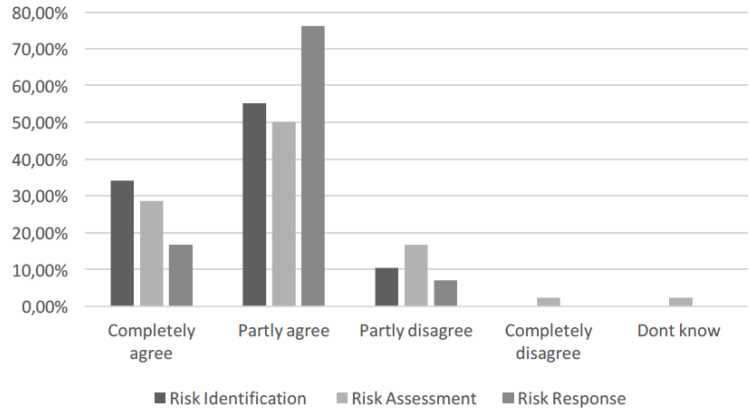

Figure 17. Respondents answer in regards to whether their organization has clear processes for identification, assessment and response to risk.

Q18 How does one answer risks?

The questionnaire consisted of additional statement questions in reference to risk response methods so as to estimate which methods they typically implement within their organizations. The majority of the respondents chose the "partly agree" option regarding avoidance at 62%, mitigation at 61% and acceptance at 55% while transfer had a response rate of 36%. Regarding the "completely agree" option the respondents most frequently chose mitigation of risks at 32%. The transfer of risks was the foremost divided opinion since 36% of the respondents chose to" partly agree" while 38% chose to "partly disagree", additionally 22% chose to completely disagree, as presented in **Fig. 18**.

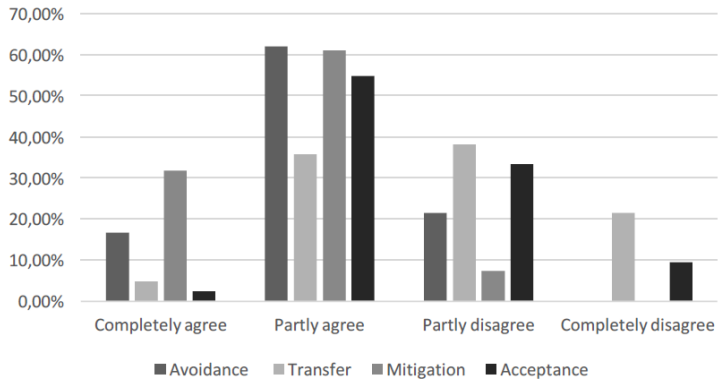

Figure 18. Respondents answer on how they respond to risk according to response methods such as avoidance, transfer, mitigation and acceptance.

5. ANALYSIS

5.1 WHAT'S THE PERCEPTION OF RISK AND RISK MANAGEMENT?

The findings indicate that the attitude among Swedish contractors regarding risk may be a combination of both opportunity and threat. This contradicts the results presented by Akintoye and Macload (1997) where the development industry is predominantly risk averse. However, the findings during this study corresponds to the reason given by Hillson and Murray Webster (2005) concerning how risk is perceived when observing official risk management standards, i.e. including both opportunity and threat instead of solely a negative connotation which was more common before the turn of the millennium. Furthermore, the overwhelming majority of the respondents in both the questionnaire and therefore the interviews described themselves as being riskneutral rather than risk-averse or risk-seekers, which coincides with previous studies like Lyons and Skitmore (2004). Hence, their attitudes and perception of risk is in line with their risk approach profile as risk-neutral decision makers. One of the interviewees viewed risk as overall negative consequences counting on the sort of risk, although he stated that a chance could be found when handling financial risks. However, the bulk of respondents described risks as two-fold in terms of threat and opportunity since risks might cause exploring other ways of managing hazardous situations which may be more prosperous.

The overall perception of risk management in terms of the importance of adopting an efficient process of managing the risks where shared among all the interviewees. all of them felt that managing risk is critical so as to realize project objectives. The projects within the construction industry is crammed with risks and uncertainty, thus it's essential to possess an efficient risk management process in situ. The concept described in literature facilitates the power to maximize the opportunities and simultaneously reduce the threats. However, no universal standard or method might be observed among the respondents within the interviews, the implementation of risk management varied in practice and none of the respondents had previous knowledge of the concepts within the structured manner as are often found in literature. Nonetheless, the four stages (identification, assessment, response, monitoring) where considered the core process within the development industry albeit there are many methodologies used for risk management, as affirmed by Smith et al (2006).

The questionnaire revealed that the respondents perceived risk management to be most important during the design and production phase instead of the conceptual and completion phase, the finding corresponds with the study made by Lyons and Skitmore (2004) which contradicts the opinion that the conceptual phase is that the most essential for risk management. However, the result illustrates that each phase is taken into account highly important since the planning and production phase didn't exceed the opposite phases significantly. This outcome is probably thanks to the very fact that the participants of the questionnaire consisted of varied

professions within the industry, during which different risks are considered. Furthermore, out of the four core processes in risk management the respondents viewed risk identification to be most vital while assessment, response and monitoring were rather equally significant. This parallels the claim by Banaitene and Banaitis (2012) that the identification process could be viewed because the most vital step.

5.2 HOW IS KNOWLEDGE MANAGED IN REFERENCE TO RISK MANAGEMENT?

Inadequate knowledge regarding risk management, because it is described in literature, seem to be a common thread amongst the respondents, albeit they in practice actually implement some of the theoretical strategies without being conscious of it. However, the findings from the interviews revealed that none of respondents had read any separate courses in risk management, instead a number of them had RM interwoven in other sorts of training like internal education in safety, another respondent had read construction law as an example. Thus, albeit 60% of the respondents had education in RM consistent with the survey, it'd be a touch misleading if they perceived the courses as non-separate RM courses. Another interesting observation was that a better number of contractors provided education in RM as against the developers and the overall quality of the courses seem to be viewed as average. Still, the bulk of the survey participants perceived themselves as somewhat knowledgeable in risk management. The results from the questionnaire indicate that lack of your time is that the biggest obstacle for an insufficient risk management implementation which is according to research by Lyons &

Skitmore (2004) and Ly et al (2005). Insufficient knowledge during this area might stem from the lack of your time within the development industry. The findings suggest that there's no shortage of information but the shortage of competence is noticeable. Tan et al (2010) states that the phases in the construction industry are temporary and fragmented which complicates the method of managing knowledge. This issue could even be identified though the questionnaire and interviews since lack of your time was the predominant factor among both respondents, and new projects often begin without making time for the individual to reflect on the risks from the previous project.

Other obstacles discovered though the info collection was the general corporate culture within the industry, as an example a fear of sharing bad experience which could contribute to the rise of unknown unknowns as described by Winch (2010) regarding project risk classification. Counterintuitively it's perhaps the foremost important experience one could share so as to improve on RM in construction projects. Another a part of the culture issue is that the notion that things are alleged to be handled as they need always been, indicating some fear of change within the industry. The findings also indicate that one among the most important difficulties is that the transfer of knowledge between employees which may be a fundamental issue in terms of creating tacit knowledge accessible to be used by others, as described by King (2009). Time constraints and therefore the cultural practice within the development industry are prominent factors for insufficient capture and transfer of project knowledge in similar research (Ly et al., 2005).

The organizations learn from previous projects mainly though communities of practice and knowledge repositories, both methods had equal frequency among the respondents. The interviews revealed that the bulk of respondents felt satisfied with the experience documentation through internal knowledge repositories, although the most important hurdle was to achieve an efficient thanks to transfer individual knowledge and therefore the distribution of that knowledge throughout the organization. Tah et al (2001) described the capture of RM experience through the utilization of data repositories but the matter in practice was the extremely high number of documents and data which might be intimidating, especially when time constraints may be a big factor, on top of that another issue was that it had been too general and not specific to risks although risks are included within the data. an answer might be to make a selected risk repository as an option besides the standard database. Communities of practice was facilitated through the arranged meetings among colleagues at various levels, like separate site and construction manager gatherings also as creating meetings including both management and occupational workers. Thus, the tactic of socialization as explained within the SECI-model was frequent within the process of sharing tacit knowledge among respondents. Review of projects and therefore the challenges faced by coworkers where shared during which risks and threats was discussed but the findings revealed that they typically didn't have RM as an exclusive segment during these meeting. how to reinforce the distribution of data for risks especially might be to include separate risk meetings during these gatherings.

The questionnaire results indicate a significantly better communication about risk among respondents that worked in smaller construction companies compared to larger sized companies. Furthermore, the interviews revealed that smaller sized contractors tend to possess one project manager that follows the whole project and is involved in multiple areas like procurement, planning, makes purchases and has daily contact with production, developers and authorities. that specific person has the simplest knowledge about the project and it are often critical if that person quits the work leading to a loss of tacit knowledge but also the new knowledge that is created throughout the actual project, as described by Anumba et al (2005). The decision-making routes are naturally shorter for smaller sized contractors yielding a far better communication, but the down side is that they become more person-dependent, which in itself is a risk. At larger construction sites it's increasingly important that the one that is responsible for work environment risk is on the brink of production since the danger of being too far away from those suffering from them is higher. The larger contractors can take more risks thanks to the financial muscles and a bigger property portfolio, in order that they can afford a nasty result for a couple of years compared to smaller sized companies. However, larger companies mean larger organizations which means that communication among multiple professionals within the organization have a better possibility to fail. On the opposite hand, larger contractors have the capacity to use professionals working exclusively with risk management which may be a big advantage.

5.3 HOW IS RISK MANAGEMENT IMPLEMENTED WITHIN THE SWEDISH CONSTRUCTION INDUSTRY?

Risk management for projects within the development industry may be a formal process with the aim to identify, assess and response to potential threats and and opportunities. The questionnaire revealed that construction companies in Sweden seemed to have partially clear processes regarding the core elements, i.e., identification, assessment and response to risks. Furthermore, risk identification was viewed because the most rigid process amongst the respondents which corresponds with research made by Uher and Toakley (1999) and Lyons and Skitmore (2004).

5.3.1 THE IDENTIFICATION OF RISKS

Respondents indicated a reliance on mainly experience when it involves personal identificationof risks, after which analysis and knowledge was used. However, a study made by Maytorena et al (2007) suggests that the element of experience for risk identification is a smaller amount significant than it is commonly assumed to be. Their findings revealed that the extent of education and RM training also as information search style played the most important part in risk identification performance. the foremost common methods for identification of risks among the respondents where checklists, experience from previous projects and brainstorming which is according to several comparable studies (Chapman 2001; Lyons & Skitmore, 2004; Akintoye & MacLeod 1997). attention on financial risk identification is that the initiative upon receiving a bid request according to the interviewees, during which the contractor evaluates the developer and therefore the project at hand so as to se if it's a beneficial endeavor. However, the bulk of the respondents worked in production with work environment risks where the usage of checklists where predominant, an example of a checklist is presented in appendix 8.2. They facilitated preventive routines within each project where they might review the development site a minimum of hebdomadally with the aim to spot risks and document them on checklists. the method might be describedas proactive instead of having a reactive approach, the latter is usually the case within the construction industry consistent with Loosemore et al (2006). Respondents stressed the importance of a daily implementation of this method as long as new risks often arise. The usage of brainstorming within project teams (communities of practice) where common through arranged meetings, with the aim to debate the identified risks and share experience from previous projects. The regular meetings usually consisted of site managers and supervisors but in larger projects the development manager and project managers were involved more often. The management also made bound to have the occupational workers attain the meetings since they add production and are within the frontline of safety and work environment risk. PMI (2000) describes the importance of involving multiple project stakeholders within the risk identification process, that belief seem to be shared among the respondents and their respective organizations. When combining the findings from the questionnaire and therefore the interviews it can observed that professionals within the housing industry are using risk identification methods as described in literature. However, none of the interviewees had read any courses in risk management, instead they followed their own organizational RM procedures which might be described as analogous to RM in literature.

5.3.2 THE ASSESSMENT OF RISKS

The findings from the questionnaire illustrates that qualitative risk assessment were utilized in higher variety than the quantitative methods. Probability and impact assessment, risk register and risk matrix techniques were utilized in highest frequency among the respondents in terms of qualitative assessment, while probability analysis or no method where commonest when it came to quantitative methods. However, the interviews revealed that brainstorming in terms of discussions among team members were the most method for risk assessment as against a data driven methodology like quantitative chemical analysis. There seem to be an overall preference for the utilization of qualitative methods of risk analysis which may be confirmed during this study throughthe interviews, similar studies have reached an equivalent conclusion (Banaitene and Banaitis, 2012; Lyons and Skitmore, 2004). None of the interviewees had any knowledge of the structured techniques described in literature, instead they implemented their own assessment methods such as scoring the risks supported discussion and knowledge, during which the very best number were placed on the foremost critical risks. Respondents mentioned that the assessment process for work environment was done on a daily basis in conjunction with the protection rounds every week, during which the location managers assessed the risks immediately supported their own judgment and experience, which was also the foremost commonly used risk assessment techniques described by Lyons and Skitmore (2004). An implementation of any data driven methodologies seemed to be unnecessary in terms of labor environment risks consistent with respondents. However, respondents who also worked with financial risks where curious about data driven methods and expressed that they were willing to undertake out new tools.

5.3.4 THE RESPONSE AND MONITORING OF RISKS

There are mainly four risk mitigation strategies as described in literature, avoidance, transfer, mitigation and reduction, and eventually acceptance. The questionnaire result indicates that the Swedish housing industry most often implements avoidance and mitigation, thereafter acceptance. The transfer of risks had the foremost diverse answers and a difference between the contractors and developers might be observed, developers generally implemented the transfer of risk more frequently than the contractors. Furthermore, contractual agreements where most frequently used for transferring risk as against insurance which is according to research done by Lyons and Skitmore (2004), and respondents stated that since risk is typically associated with a price it's important to incorporate that within the contracts. it's a standard practice to “sell the risks” as another respondent expressed it. An example given was to bulldoze, one can see the surface but haven't any idea how it's underneath, therein case one could unload the danger of uncertainty beneath the surface.

The interviews revealed that respondents performed risk response strategies analogous to the methods described in literature without being conscious of it. The importance of building long-term relationships with subcontractors were mentioned among some respondents which is an avoidance strategy (PMI 2000), this helped them being more transparent and honest with each other regarding risk. In terms of labor environment, respondents engaged in risk avoidance through regular inspections on a weekly basis and preventive maintenance as described earlier. Engagement in risk response early in projects may be a risk mitigation and reduction strategy which was shared by all interviewees, like for instance changing work environment conditions immediately when seeing some potential hazard situation. A site manager mentioned that if she notices that a fall protection is missing, then it's a high priority that the railing returns in order that no one falls down and hurt themselves and she or he makes sure measures are taken immediately to reduce that risk. These sorts of work environment risks are assessed hebdomadally and therefore the priority is often determined by the experience of the location or construction manager. Flanagan et al (2007) describes an example of the mitigation strategy when implementing altered construction methods, this is often facilitated through discussions and brainstorming between site managers and the occupational workers, as revealed by the interviews. Risk acceptance was shared among respondents in terms of small risks, meaning they were conscious of them stating “let it happen, and we will handle it then”. Thus, a risk response could be considered unreasonable for such risks as described by Cooper et al (2005).

The monitoring of risks was implemented automatically through regular checkups and documentation on checklists by the management, also as by arrangement of continuous meetings throughout the project. Risk management is certainly implemented within the Swedish housing industry, but it's not adopted within the structured way as suggested in literature. the bulk of the

respondents revealed that that they had no previous knowledge of the RM concepts as they're laid call at theory but they're still responding to risk in ways in which can be described as analogous to RM theory.

6. CONCLUSIONS

The perception of risk within the Swedish housing industry is 2-fold, including awareness of both threats and opportunities and therefore the majority of execs within the industry have a risk neutral approach, contrary to previous research. The importance of implementing an effective risk management is shared among actors within the industry, especially within the planning and production phase while risk identification was seemed to be most vital out of the four core processes.

Theoretical models and processes for risk management is fairly unknown within the Swedish construction industry and although they implement analogous methods the adoption of risk management isn't as structured as described in theory. Thus, actors partake in risk management indirectly, almost like the concepts described in literature. However, the best reason for inadequate implementation of risk management and insufficient capture of data in relation to risk is that the lack of your time, competence and therefore the corporate culture. Organizational learning in reference to risk management is especially done through the usage of data repositories and communities of practice. Still, the most important obstacle was to realize an efficient way to transfer tacit individual knowledge and therefore the distribution of that knowledge throughout the organization. Furthermore, the findings during this research revealed that risk management wasn't documented separately within the knowledge repositories and communities of practice didn't include risk management as an exclusive segment however the subject of risk was always present during these gatherings.

In a comparison between larger and smaller actors within the housing industry an observation is that smaller sized contractors evidently had better risk communication thanks to shorter decision-making routes. However, they're more person-dependent which in itself also becomes a risk. The findings conclude that construction companies in Sweden have partially clear processes regarding the four core elements of identification, assessment, response and monitoring of risk. The research revealed that the foremost common methods for risk identification among the respondents where checklists, experience from previous projects and brainstorming during arranged meetings. Qualitative risk assessment was utilized in higher variety than quantitative methods, the findings indicate that a simplistic assessment approach was preferable regarding work environment risks and data driven methodologies was deemed unnecessary apart from financial risks. Risk response and monitoring is performed analogous to literature in terms of work environment risk, the foremost frequent strategies where avoidance, mitigation and eventually acceptance while transfer of risks where more common among developers. Thus, the research revealed that the sensible implementation of risk management was like concepts in literature regarding identification, response and monitoring of risks. However, the assessment of risks varied from the literature during a higher degree. The conclusion is that albeit companies perform the processes and ideas analogous to theory they don't share definitions and concepts.

Construction companies can yield great benefit through the usage of mixing of risk- and knowledge management. This notion is however underutilized within the present. an answer could be to include specific risk repositories like the danger register alongside the knowledge database during a separate and distinctive manner and thus facilitating a neater thanks to access information about risks for similar projects. Furthermore, this is able to promote the importance of risk management since an enormous issue with the knowledge repositories is that the great deal of data, and knowledge of risks are imbedded in large stacks of documents. Exclusive segments of risk management should be integrated with communities of practice so as to endorse risk management within the corporate culture and to further enhance the organizational learning of risk management.

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